



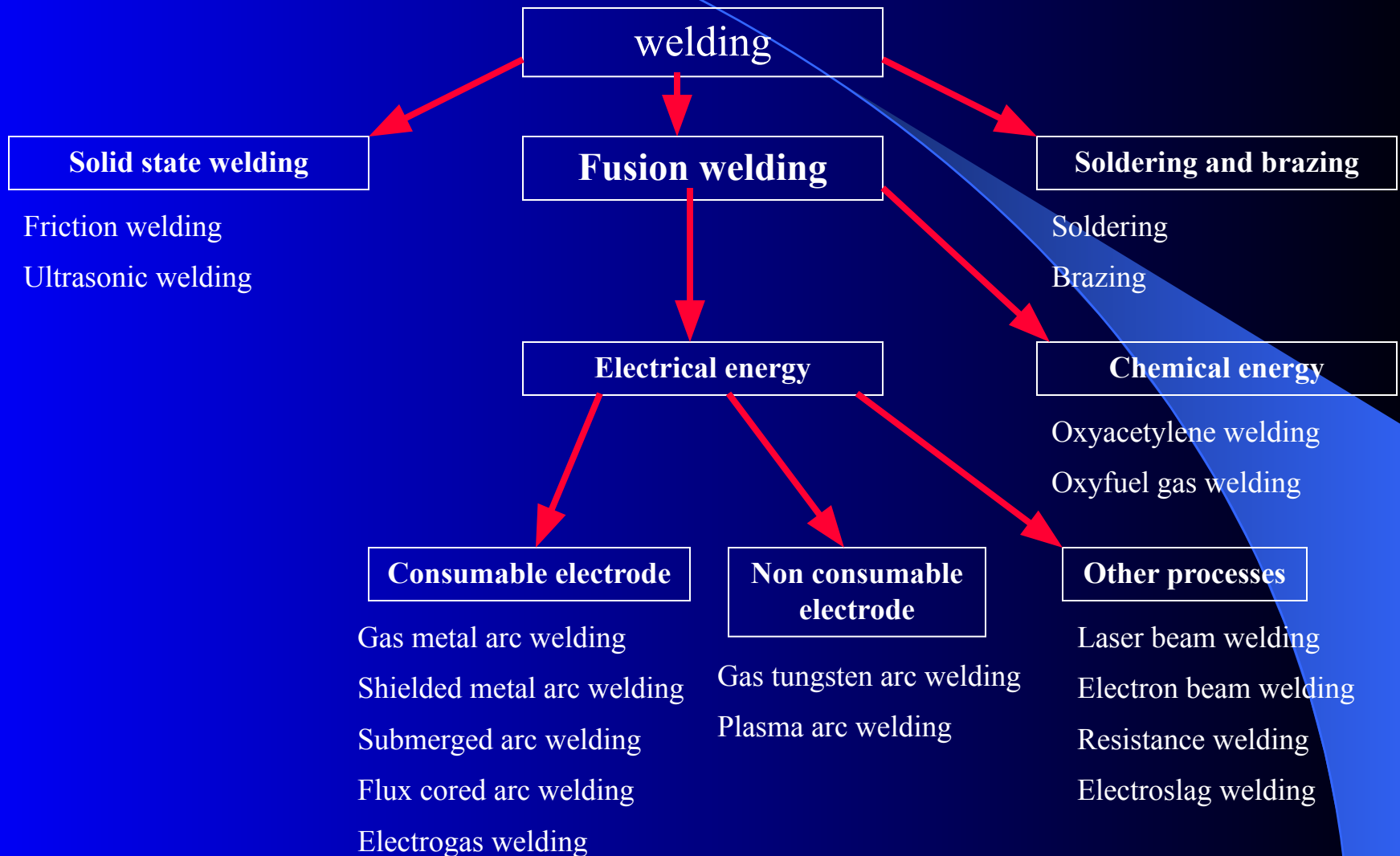
# Welding process

# Introduction

Purposes of this report: - to give an outline of welding processes

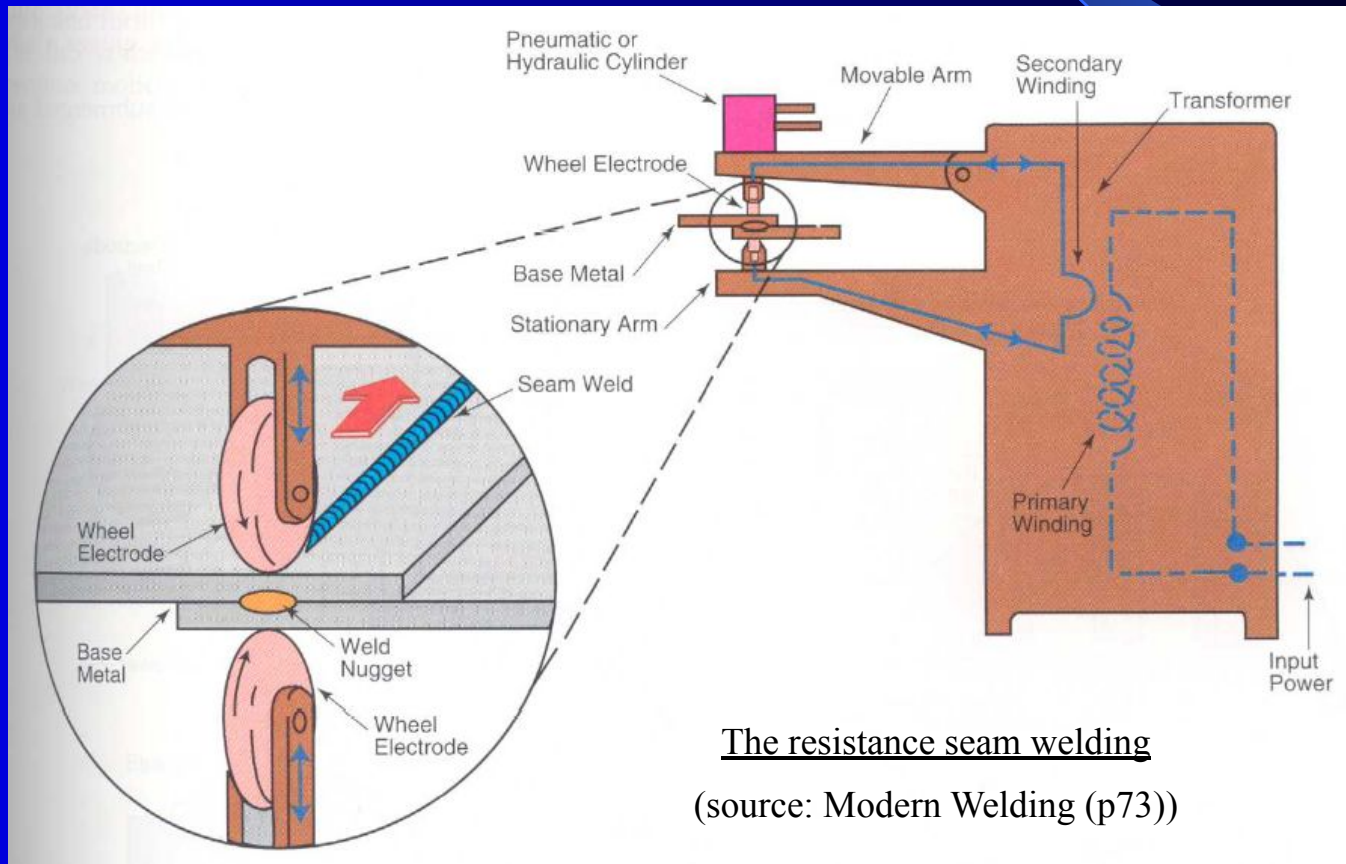
**Welding is a process of metal joining by applying heat and sometime pressure**

# Diversity of welding processes



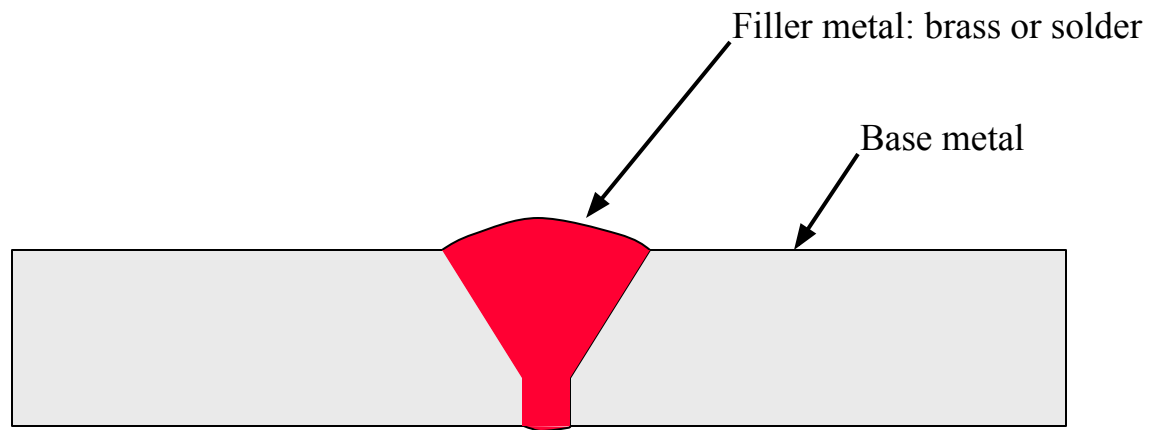
# Solid state welding

It merges all the welding processes in which there is no fusion of the workpieces .  
For example, in the solid welding process named resistance seam welding, the welding joint is produced in the wheel electrodes region by applied a current and a pressure without fusion of the base metal.



# Soldering or brazing

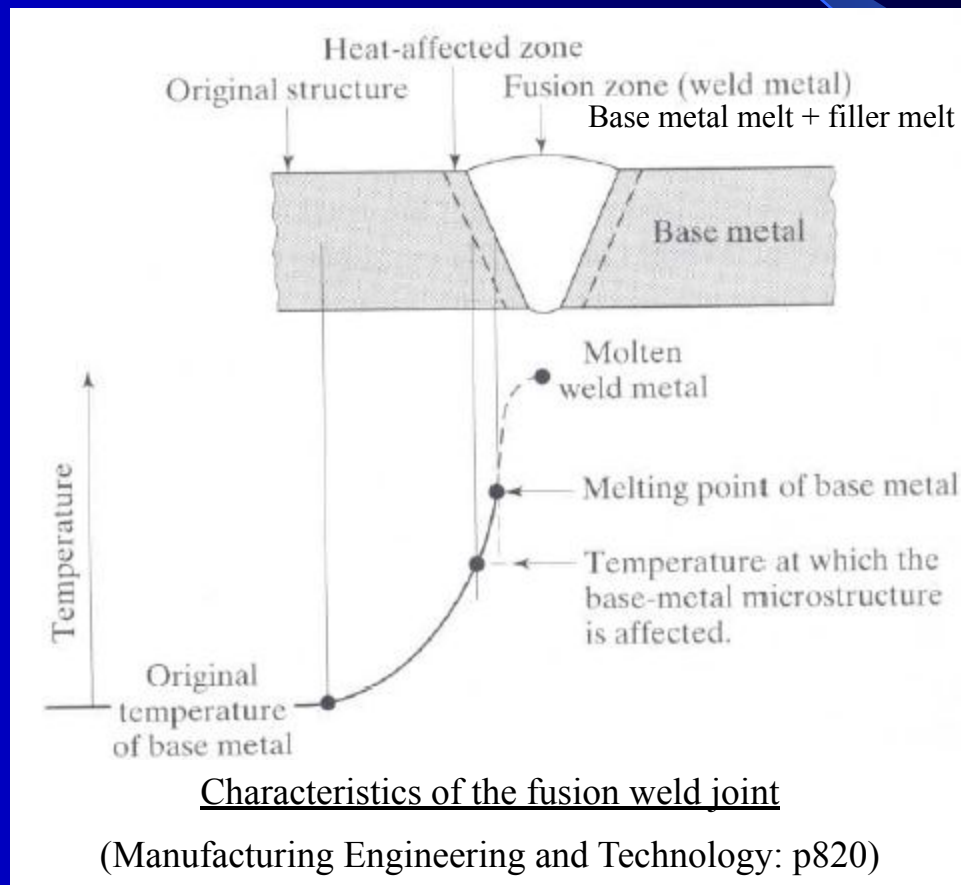
In these processes, only the filler metals which join the two pieces to be welded are melted and not the base metal. The braze metals have higher melting temperatures than the solder metals.



Characteristics of a brazed or soldered joint

# Fusion welding

This process involves the partial melting of the two members welded in the joint region. The thermal energy required for this fusion is usually supplied by chemical or electrical means.





*Fusion welding  
Process*

# Topics to Discuss

- Introduction
- Oxyfuel Gas welding
- Arc-Welding Processes:Consumable electrode
- Electrodes
- Arc-Welding Processes:Non Consumable Process
- Thermit Welding
- Electron Beam Welding
- Laser Beam Welding
- Cutting
- Welding Safety



# Introduction

- Definition : Fusion Welding is defined as melting together and coalescing materials by means of heat
- Energy is supplied by thermal or electrical means
- Fusion welds made without filler metals are known as autogenous welds

# Oxyfuel Gas Welding

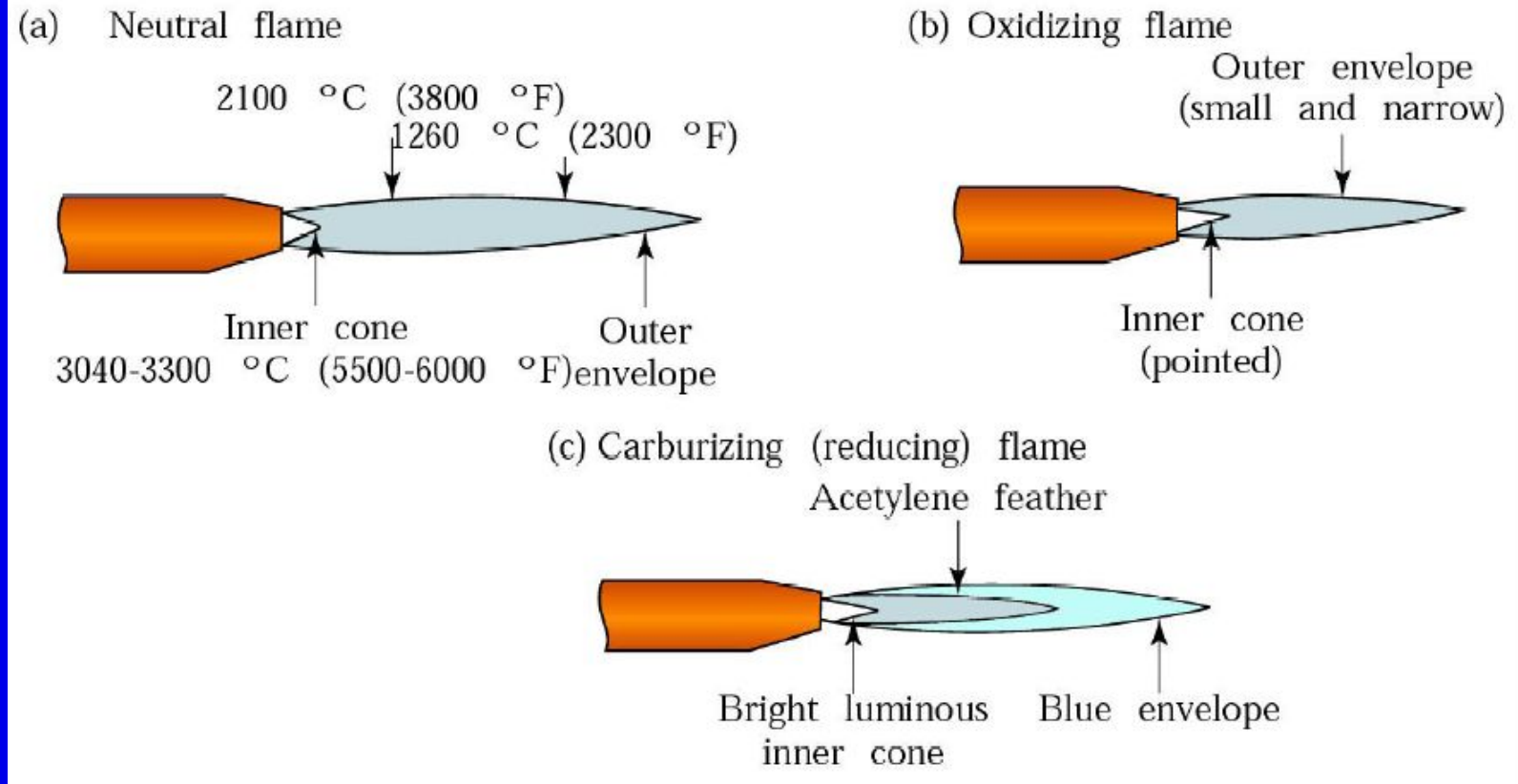


Fig : Three basic types of oxyacetylene flames used in oxyfuel-gas welding and cutting operations: (a) neutral flame; (b) oxidizing flame; (c) carburizing, or reducing flame. The gas mixture in (a) is basically equal volumes of oxygen and acetylene.

## Oxyfuel Gas Welding

- Welding process that uses fuel gas combined with oxygen to produce flame
- This flame heat melts the metals at the joint
- Acetylene fuel is used in gas welding process

Primary combustion process



- This reaction dissociates into carbon monoxide and hydrogen.

Secondary combustion process



## Types of flames

- Neutral flame
- Oxidising flame
- Carburising flame

### Filler Metals :

- Additional material to weld the weld zone
- Available as rod or wire
- They can be used bare or coated with flux
- The purpose of the flux is to retard

# Welding practice & equipment

## STEPS :

- Prepare the edges to be joined and maintain the proper position
- Open the acetylene valve and ignite the gas at tip of the torch
- Hold the torch at about 45deg to the work piece plane
- Inner flame near the work piece and filler rod at about 30 – 40 deg
- Touch filler rod at the joint and control the movement according to the flow of the material

# Torch used in Oxyacetylene Welding

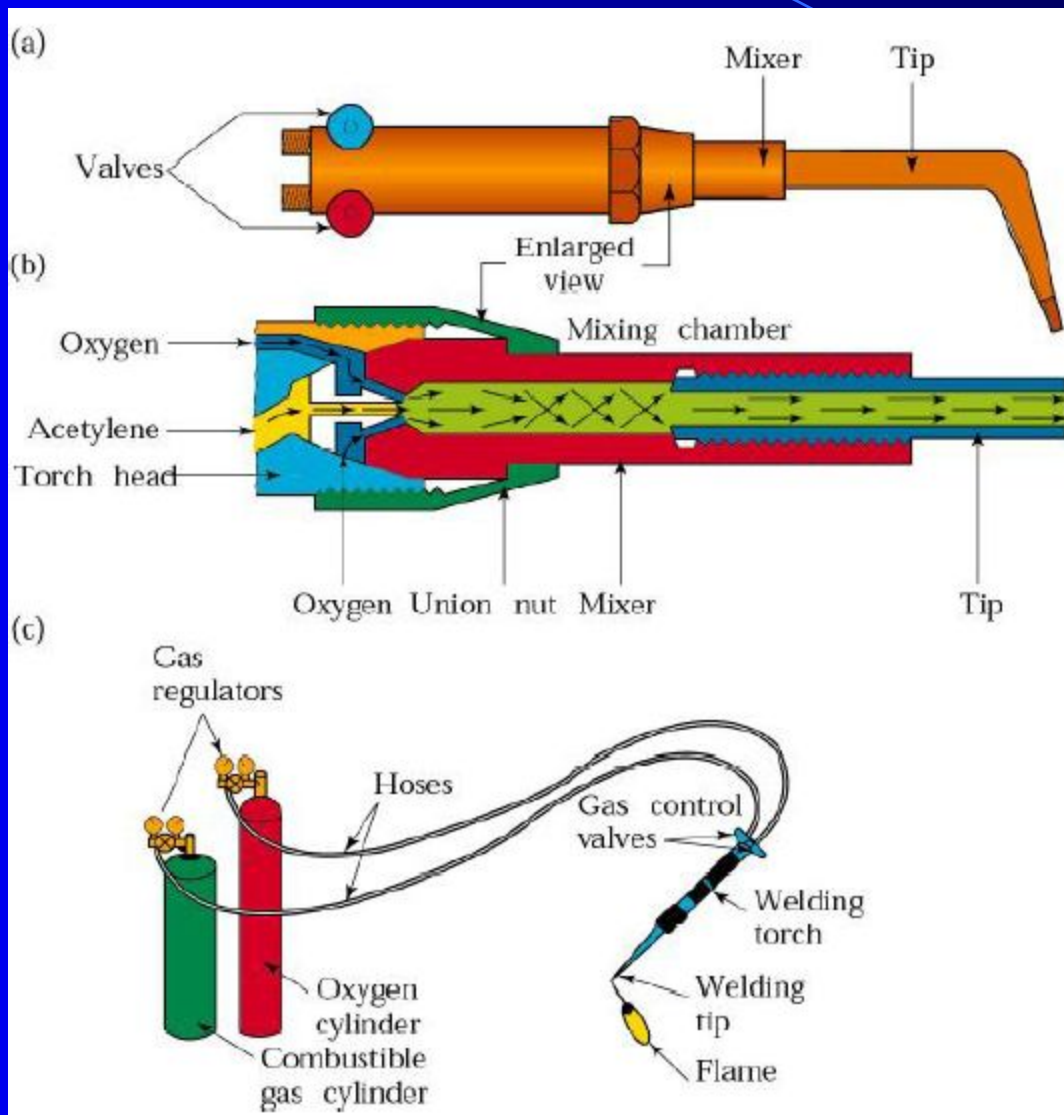


Fig : (a) General view of and (b) cross-section of a torch used in oxyacetylene welding. The acetylene valve is opened first; the gas is lit with a park lighter or a pilot light; then the oxygen valve is opened and the flame adjusted. (c) Basic equipment used in oxyfuel-gas welding. To ensure correct connections, all threads on acetylene fittings are left-handed, whereas those for oxygen are right-handed. Oxygen regulators are usually painted green, acetylene regulators red.

## Arc welding process : Consumable electrode

- Process goes with the consumable electrode or non consumable electrode
- Arc produced between the tip of the electrode & work piece
- Arc temperature about 3000 deg
- Oldest ,simple & versatile
- 50 % of industry uses this process
- heat generated heats the electrode & immediate area of the base projected by arc
- weld forms when molten metal ,mixture of base metal and electrode metal and substance from the coating on the electrode solidifies
- electrodes are in the shape of thin, long stick, so the process is known as stick welding

# Shielded metal arc welding process

Fig : Schematic illustration of the shielded metal-arc welding process ( also known as stick welding, because the electrode is in the shape of a stick).

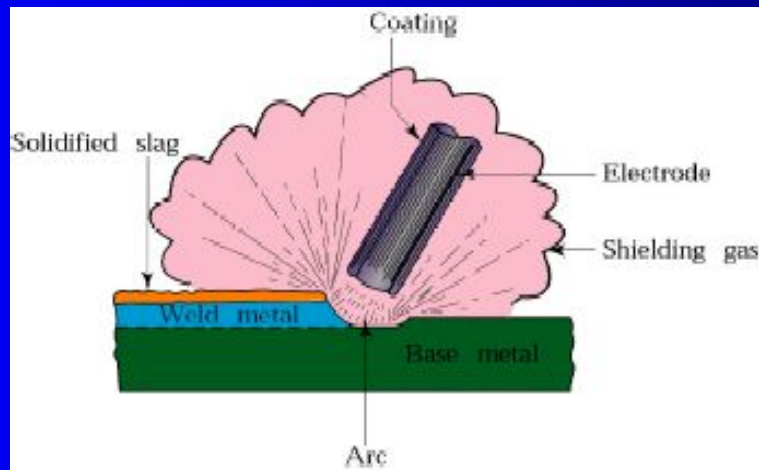
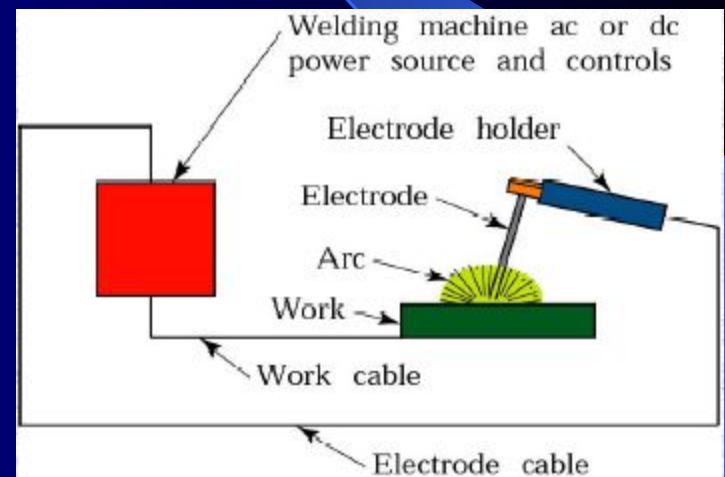


Fig : Schematic illustration of the shielded metal-arc welding process. About 50% of all large-scale industrial welding operations use this process.





# Submerged arc welding:

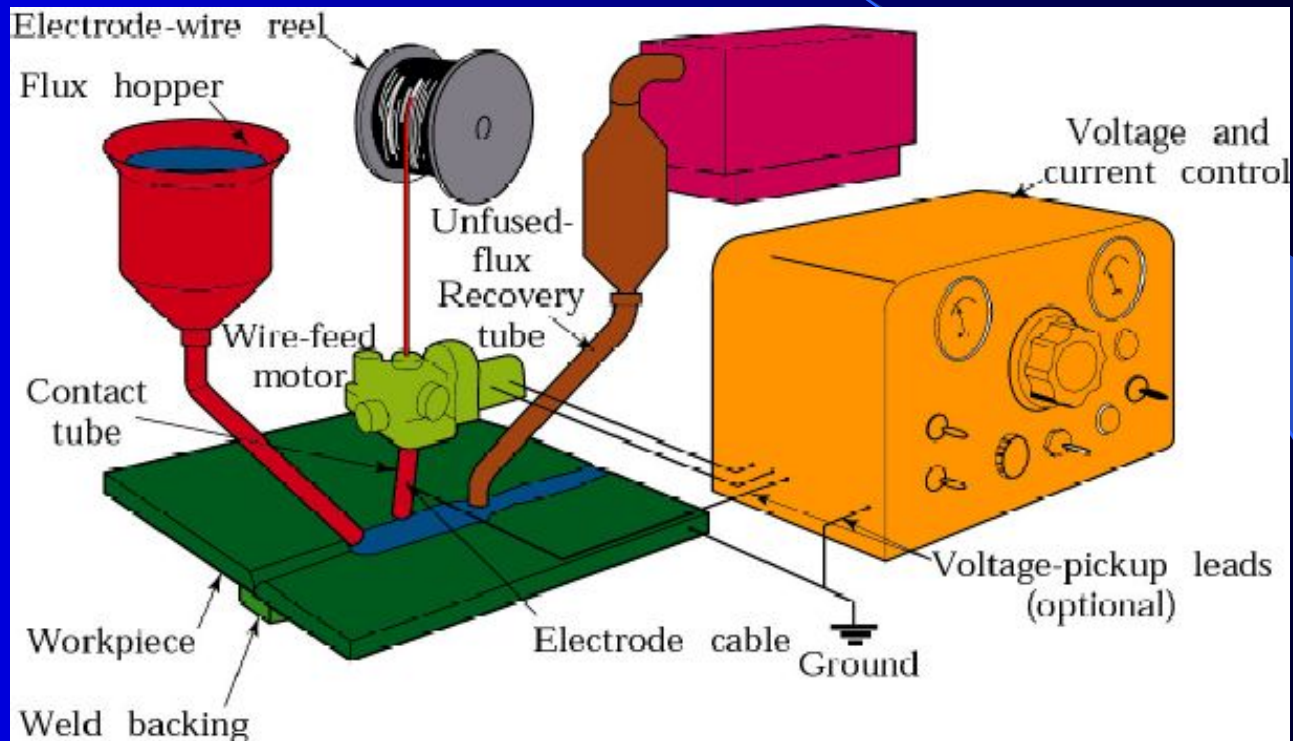


Fig : Schematic illustration of the submerged-arc welding process and equipment. The unfused flux is recovered and reused .

## Submerged arc welding:

- Weld arc is shielded by a granular flux ,consisting of silica, lime, manganese oxide, calcium fluoride and other compounds.
- Flux is fed into the weld zone by gravity flow through nozzle
- Thick layer of flux covers molten metal
- Flux acts as a thermal insulator ,promoting deep penetration of heat into the work piece
- Consumable electrode is a coil of bare round wire fed automatically through a tube
- Power is supplied by 3-phase or 2-phase power lines

## Gas metal arc welding:

- GMAW is a metal inert gas welding (MIG)
- Weld area shielded by an effectively inert atmosphere of argon, helium, carbon dioxide, various other gas mixtures
- Metal can be transferred by 3 methods :
- Spray transfer
- Globular transfer
- Short circuiting

### Process capabilities

- GMAW process is suitable for welding a variety of ferrous and non-ferrous metals
- Process is versatile ,rapid,economical,welding productivity is double that of SMAW

# Gas Metal-Arc Welding

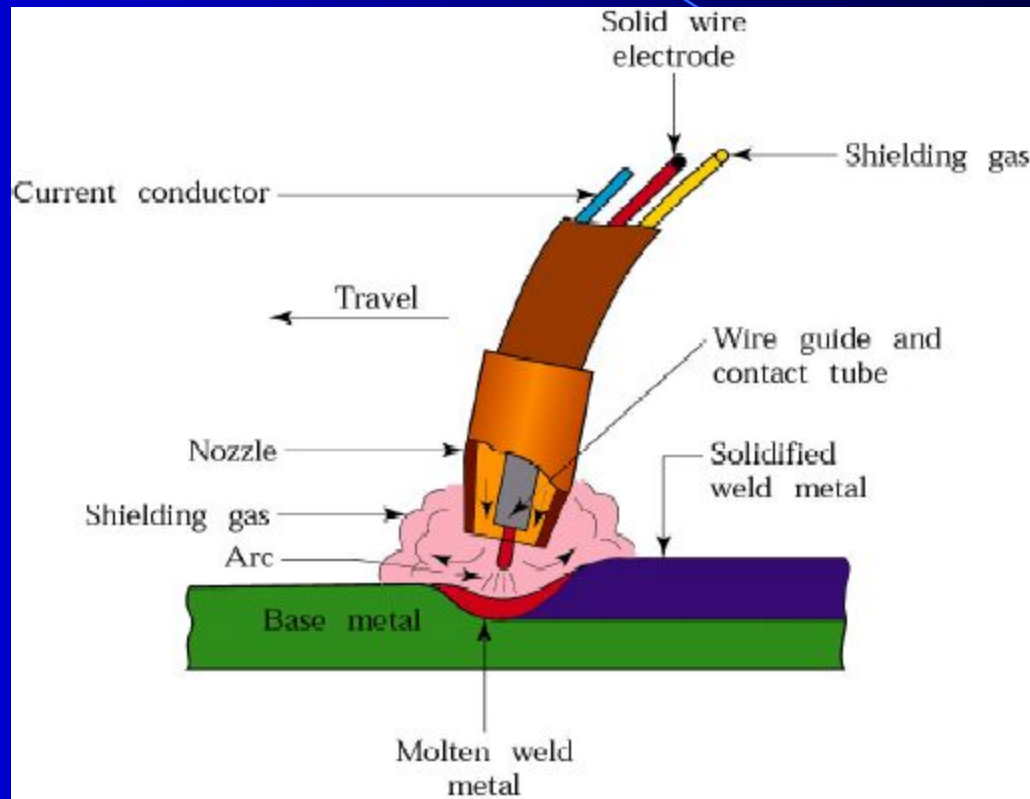


Fig : Schematic illustration of the gas metal-arc welding process, formerly known as MIG (for metal inert gas) welding.

# Equipment used in Metal-Arc Welding Operations

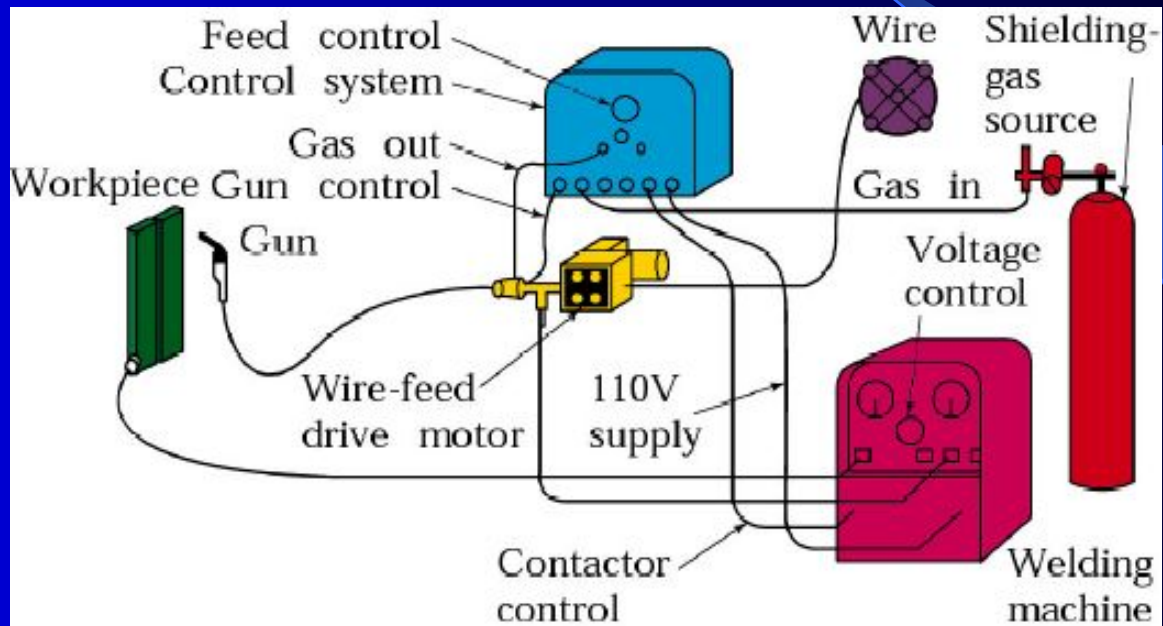


Fig : Basic equipment used in gas metal-arc welding operations

## Flux-cored Arc – Welding

- Flux cored arc welding is similar to a gas metal arc welding
- Electrode is tubular in shape and is filled with flux
- Cored electrodes produce more stable arc improve weld contour and produce better mechanical properties
- Flux is more flexible than others

# Flux-Cored Arc Welding

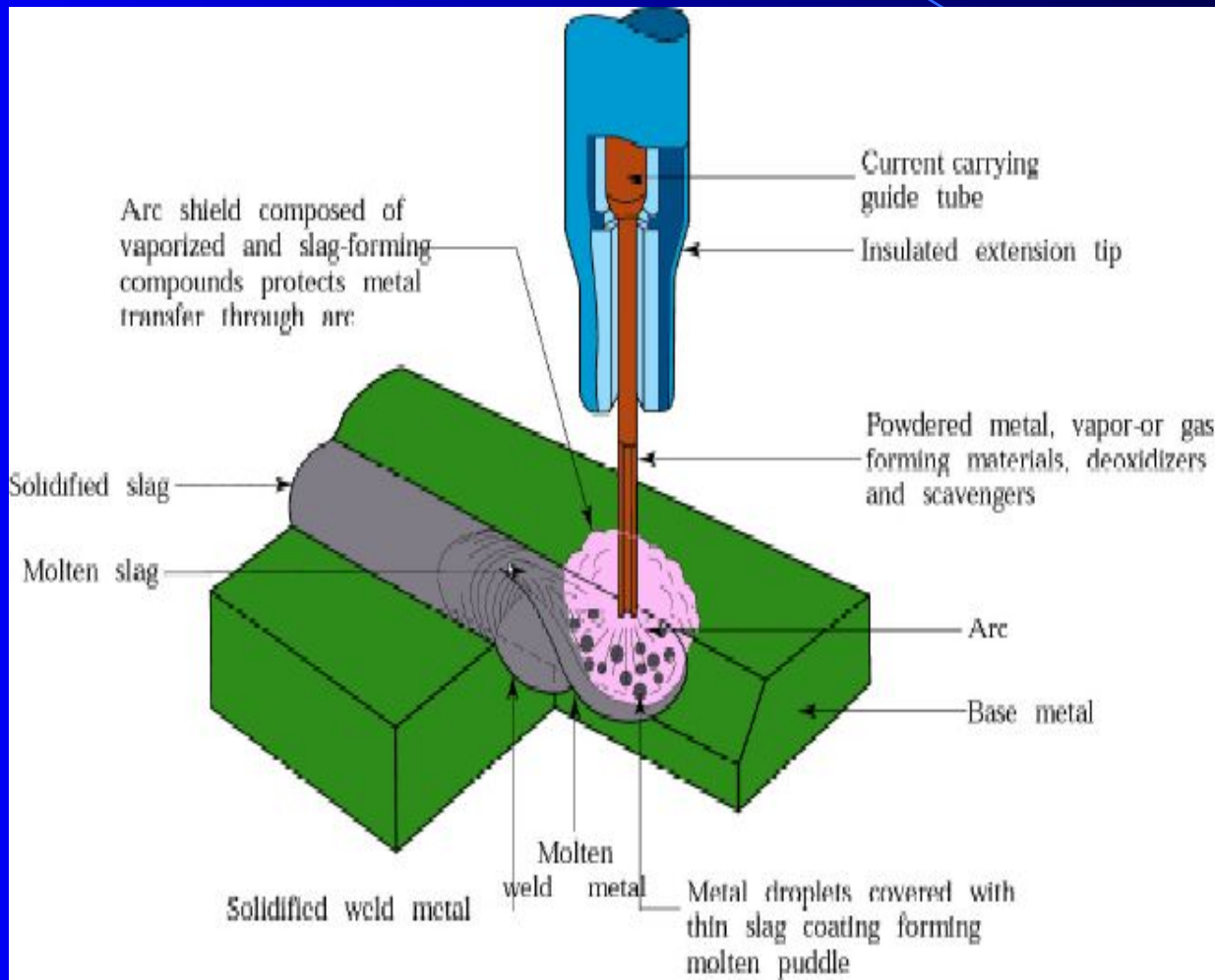


Fig : Schematic illustration of the flux-cored arc-welding process. This operation is similar to gas metal-arc welding.

## Electro gas Welding :

- EGW is welding the edges of sections vertically in one pass with the pieces placed edge to edge
- Weld metal is deposited into weld cavity between the two pieces to be joined
- Mechanical drives moves shoes upwards
- Single and multiple electrodes are fed through a conduit and a continuous arc is maintained using flux-cored electrodes at up to 750 A

### Process capabilities :

- Weld thickness ranges from 12mm to 75mm
- Metals welded are steels, titanium, aluminum alloys
- Applications are construction of bridges, pressure vessels, thick walled and large diameter pipes, storage tanks and ships.



# Electrogas Welding

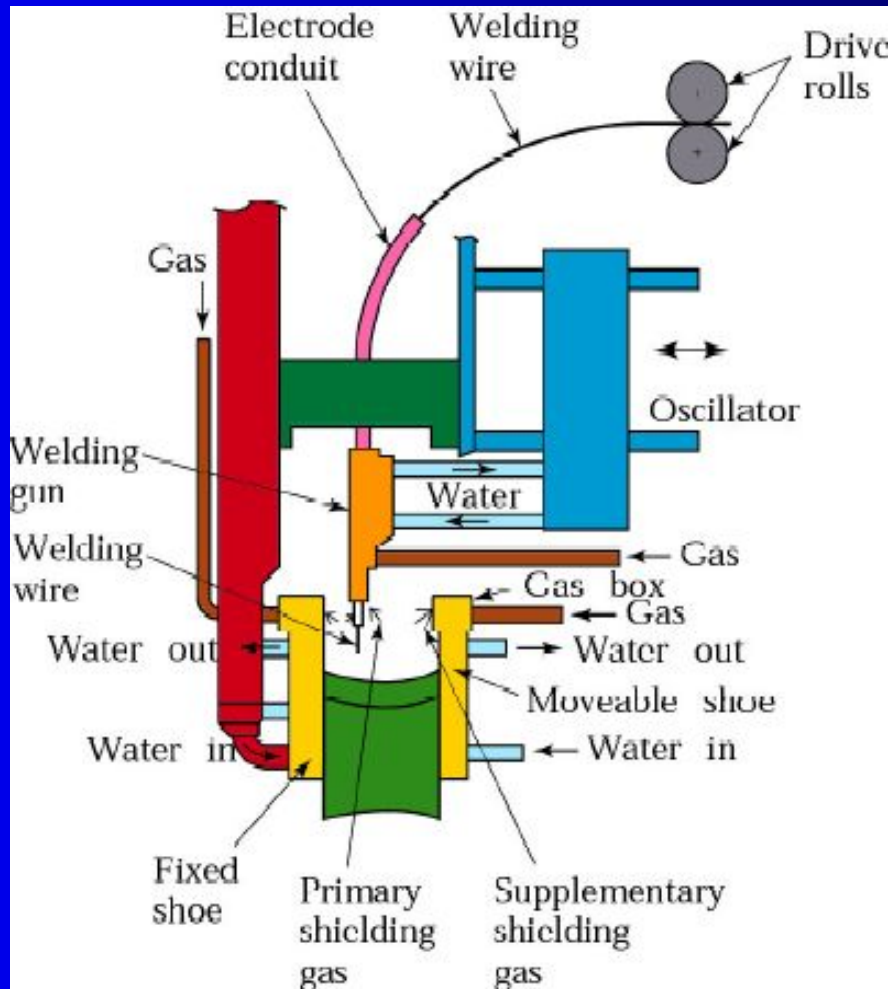


Fig : Schematic illustration of the electrogas welding process

## Electroslag Welding:

- Similar to Electro gas welding
- Difference is Arc is started between electrode tip and bottom part of the part to be welded
- Flux added first and then melted by the heat on the arc
- Molten slag reaches the tip of the electrode and the arc is extinguished
- Heat is then continuously produced by electrical resistance of the molten slag
- Single or multiple solid as well as flux-cored electrodes may be used

# Equipment used in Electroslag welding

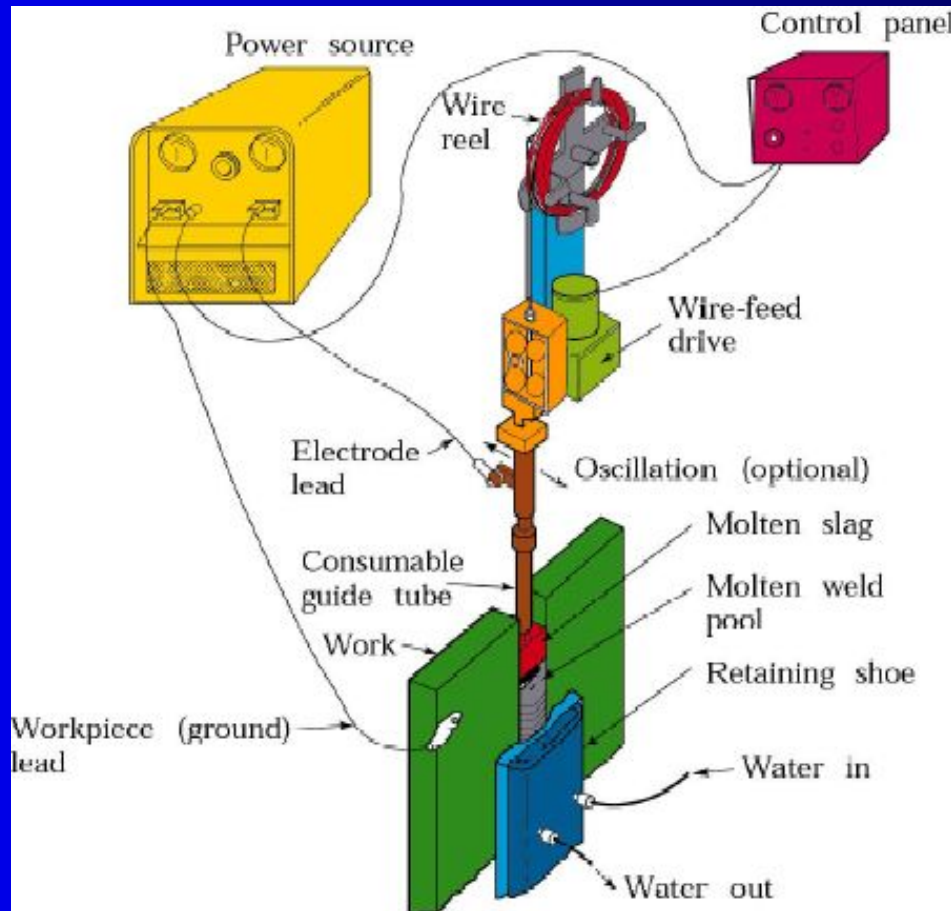


Fig : Equipment used for electroslag welding operations.



*Solid-State Welding  
Processes*

# Cold Welding

- Pressure is applied to the workpieces through dies or rolls
- Preferably both work pieces should be ductile
- The work pieces should be cleaned thoroughly
- Can not join dissimilar metals

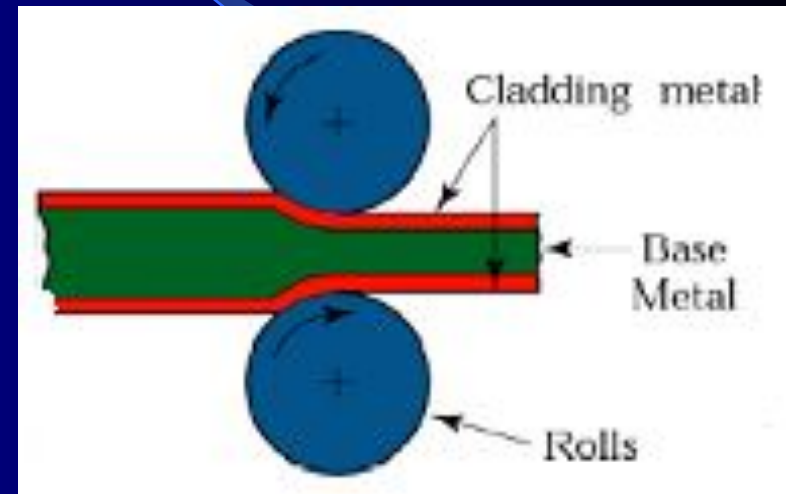


Fig: The roll bonding or cladding process

# Ultrasonic Welding

- Surfaces of the two components are subjected to a static forces and oscillating shearing force
- Produces a strong, solid-state bond
- Versatile and reliable for joining metals

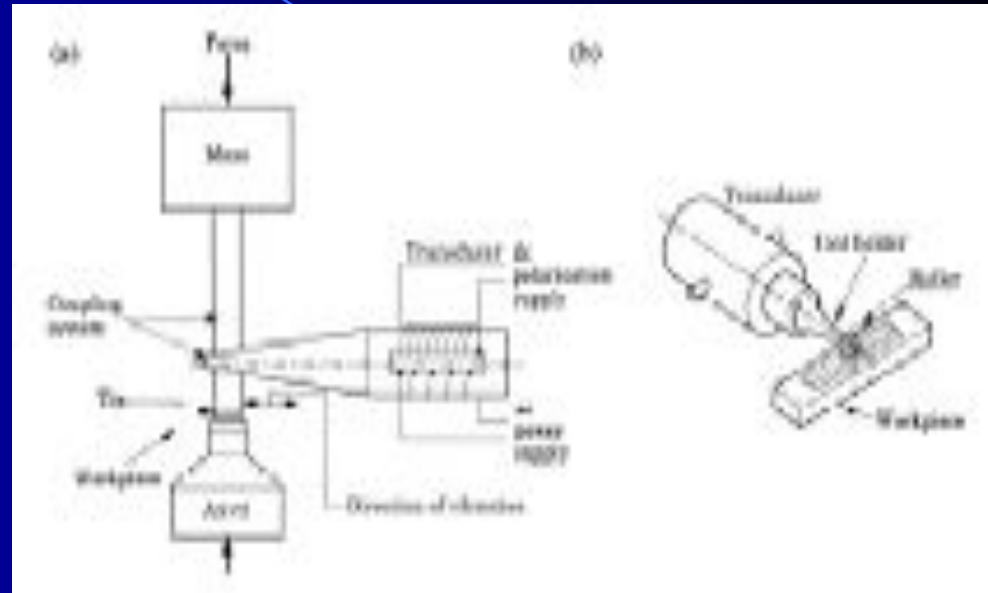


Fig: a) Components of an ultrasonic welding machine for lap welds. The lateral vibration of the tool tip cause plastic deformation and bonding at the interface of the work piece b) Ultrasonic some welding using a roller c) An ultrasonically welded part

# Friction Welding

- Developed in the 1940's
- Parts are circular in shape
- Can be used to join a wide variety of materials

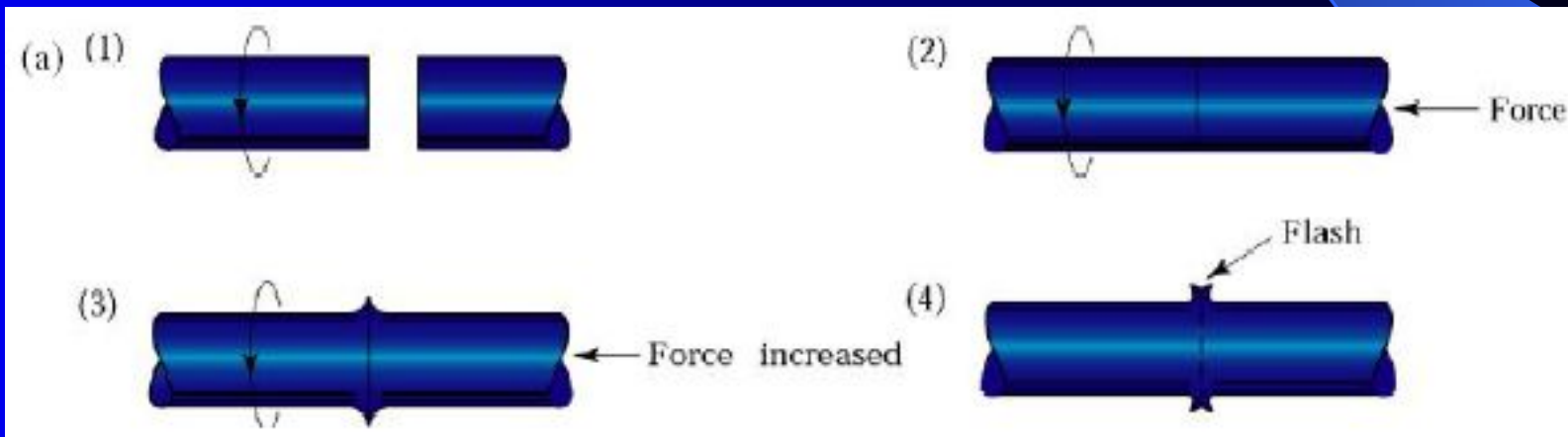


Fig: Sequence of operation in the friction welding process 1) Left-hand component is rotated at high speed. 2) Right-hand component is brought into contact under an axial force 3) Axial force is increased; the flash begins to form 4) Left-hand component stops rotating; weld is completed. The flash can subsequently be removed by machining or grinding

# Friction Welding

- Process can be fully automated
- Can weld solid steel bars up to 250mm in outside diameter

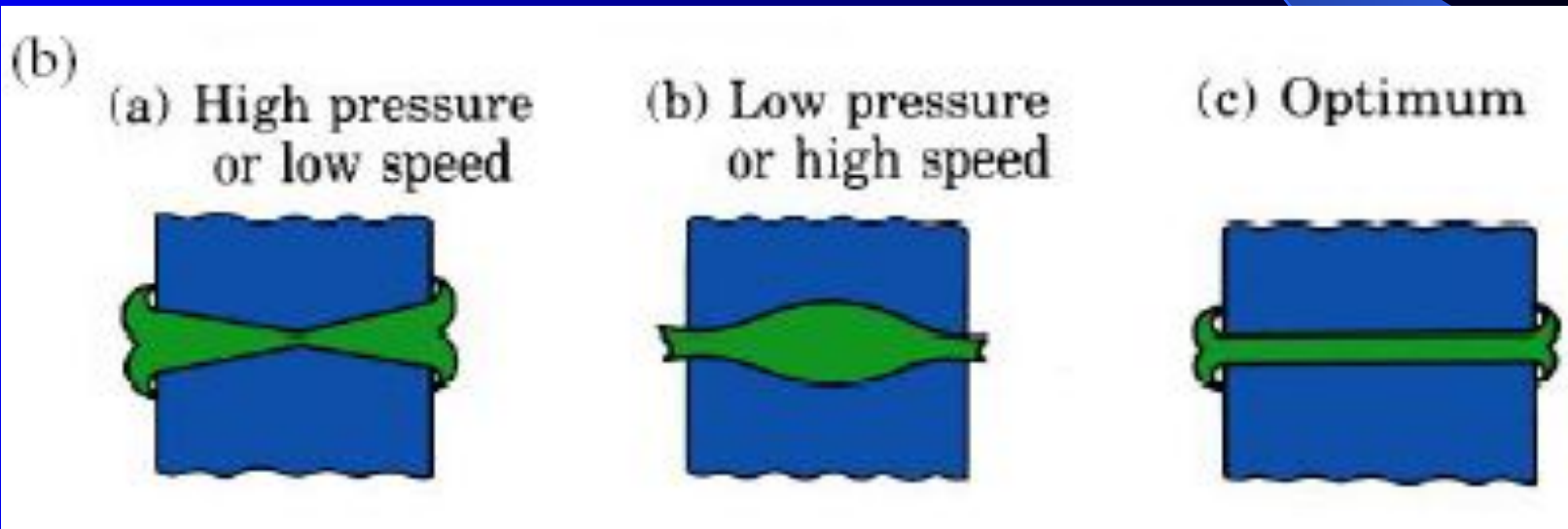


Fig:Shape of friction zone in friction welding,as a function of the force applied and the rotational speed



# Inertia Friction Welding

- Modification of Friction Welding
- Energy is supplied by a fly wheel
- The parts are pressed together by a normal force
- As friction at the interface increases, the fly wheel slows down
- The weld is completed when the flywheel stops

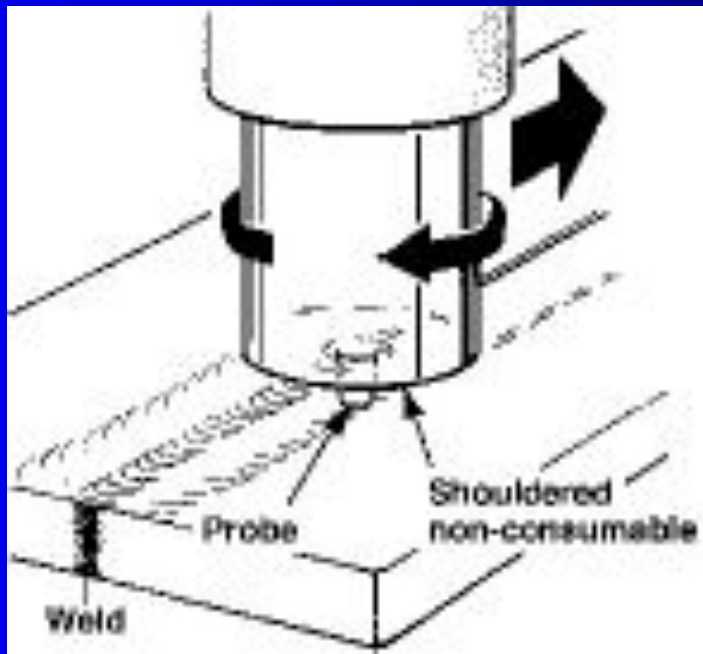


Fig : The principle of the friction stir welding process. Aluminum-alloy plates up to 75mm (3in) thick have been welded by this process

## *Linear Friction Welding*

- Parts are joined by a linear reciprocating motion
- Parts do not have to be circular or tubular
- In this application, one part is moved across the face of the other part using a balanced reciprocating mechanism

## *Friction Stir Welding (FSW)*

- New Process for welding aerospace metals
- Research is being directed towards using this process for polymers
- FSW uses a 3<sup>rd</sup> nonconsumable tool inserted between the two bodies to heat the material to be joined

# *Resistance Welding*

- Developed in the early 1900's
- A process in which the heat required for welding is produced by means of electrical resistance across the two components
- RW does not **requiring the following:**
  - Consumable electrodes
  - Shield gases
  - Flux

# Resistance Spot Welding

- RSW uses the tips of two opposing solid cylindrical electrodes
- Pressure is applied to the lap joint until the current is turned off in order to obtain a strong weld

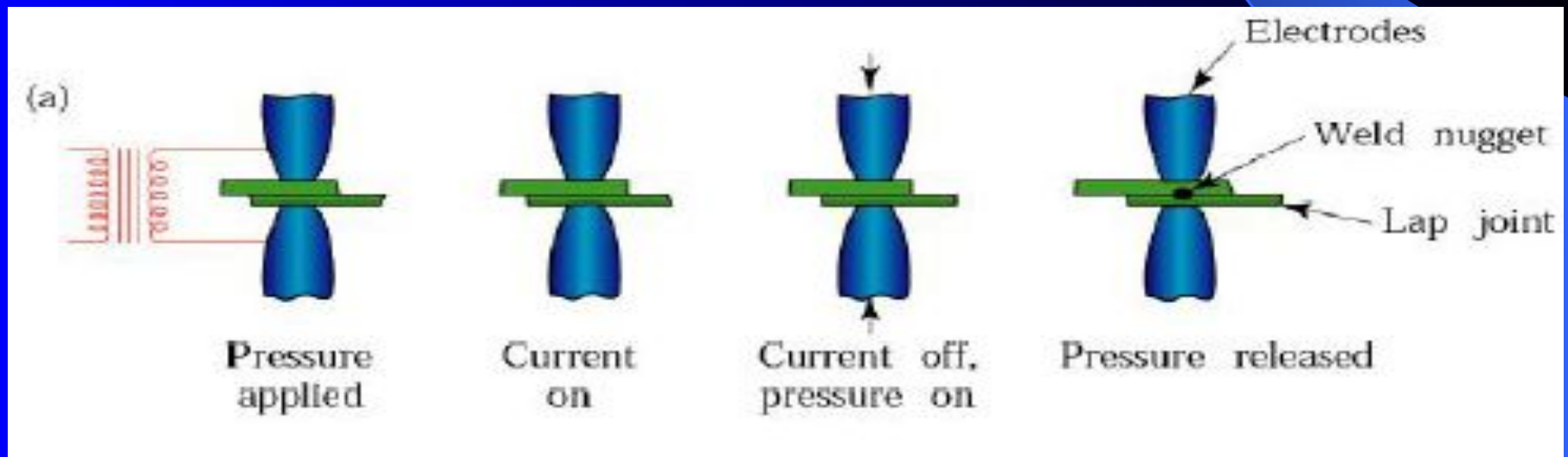


Fig: (a) Sequence in the resistance spot welding

# Resistance Spot Welding

- Surfaces should be clean
- Accurate control of and timing of electric current and of pressure are essential in resistance welding

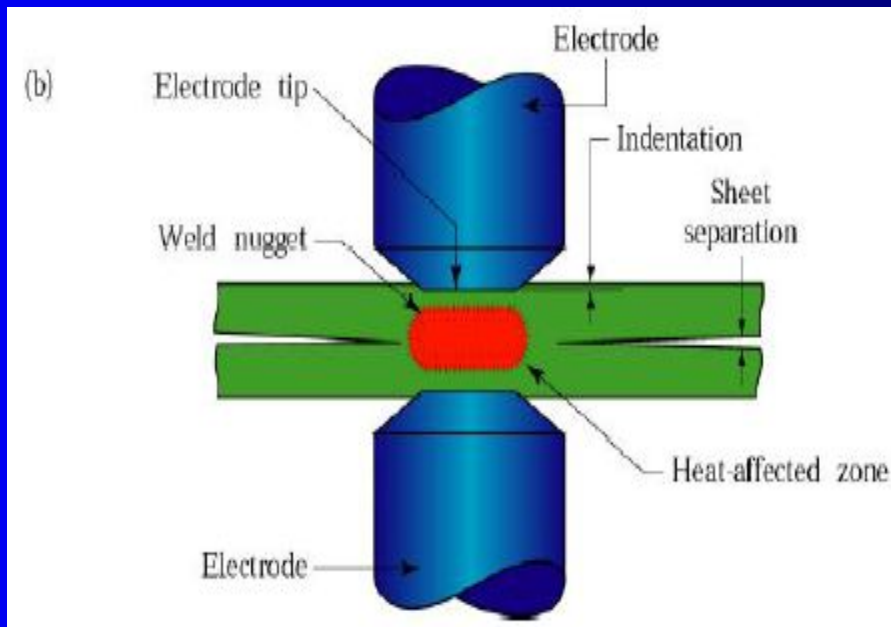


Fig: b) Cross-section of a spot weld, showing the weld nugget and the indentation of the electrode on the sheet surfaces. This is one of the most commonly used process in sheet-metal fabrication and in automotive-body assembly

# Resistance Seam Welding

- RSEM is modification of spot welding wherein the electrodes are replaced by rotating wheels or rollers
- The electrically conducting rollers produce a spot weld
- RSEM can produce a continuous seam & joint that is liquid and gas tight

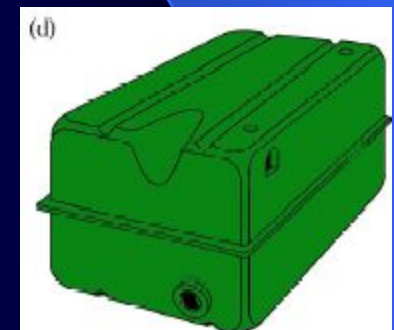
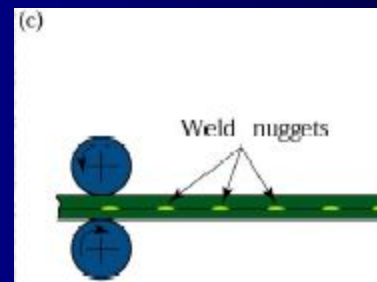
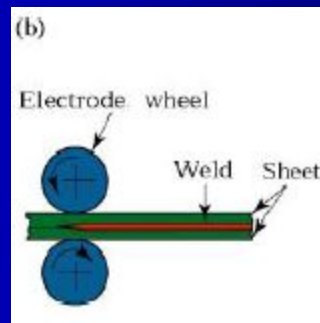
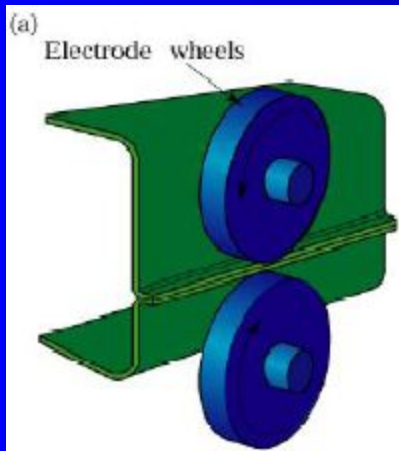


Fig : (a) Seam-Welding Process in which rotating rolls act as electrode (b) Overlapping spots in a seam weld. (c) Roll spot weld (d) Resistance-welded gasoline tank

# Resistance Projection Welding

- RPW is developed by introducing high electrical resistance at a joint by embossing one or more projections on the surface to be welded
- Weld nuggets are similar to spot welding

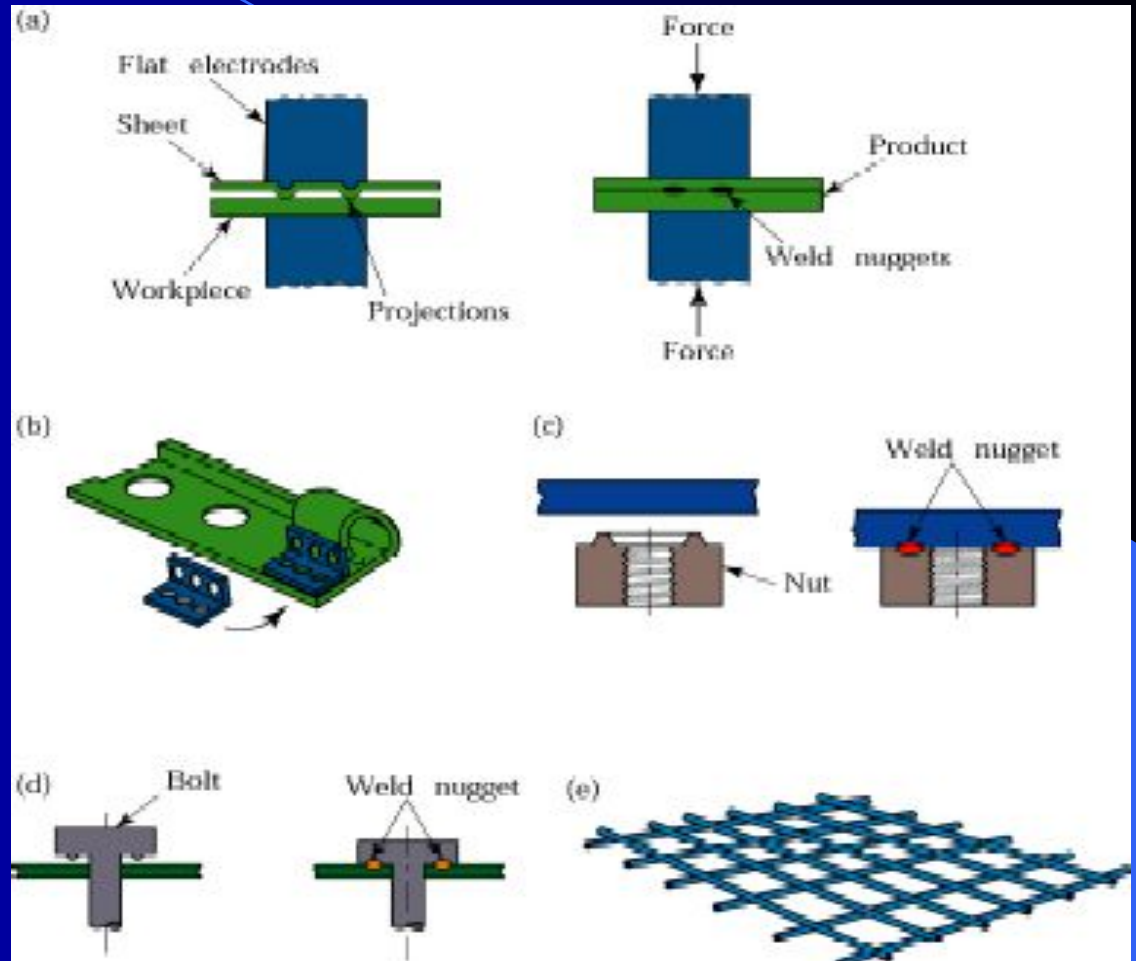


Fig: a) Resistance projection Welding b) A welded bracket c) & d) Projection welding of nuts r threaded hoses and stack



# Resistance Projection Welding

- The electrodes exert pressure to compress the projections
- Nuts and bolts can be welded to sheet and plate by this process
- Metal baskets, oven grills, and shopping carts can be made by RPW

# Flash Welding

- Heat is generated from the arc as the ends of the two members contact
- An axial force is applied at a controlled rate
- Weld is formed in plastic deformation

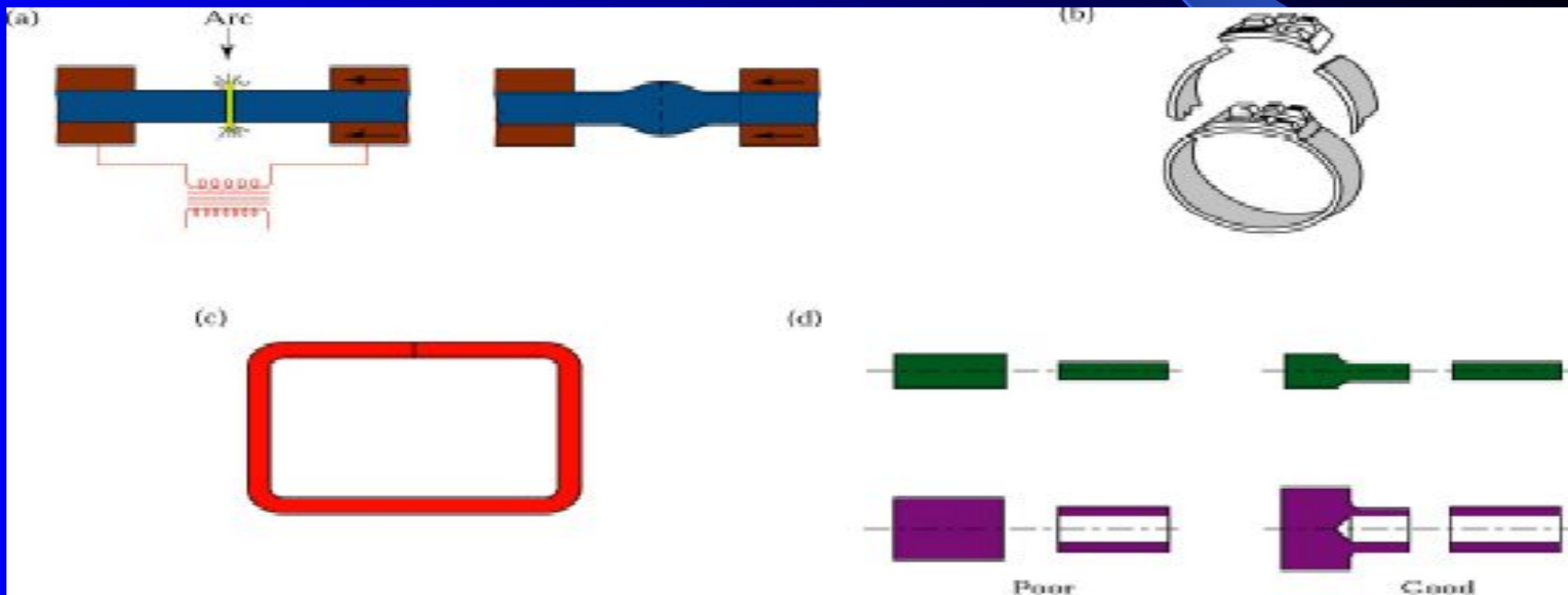


Fig : (a)Flash-welding process for end-to –end welding of solid rods or tubular parts  
(b) & (c) Typical parts made by flash welding (d)Design Guidelines for flash welding

# Stud Welding

- Small part or a threaded rod or hanger serves as an electrode
- Also called as Stud arc welding
- Prevent oxidation to concentrate the heat generation
- Portable stud-welding is also available

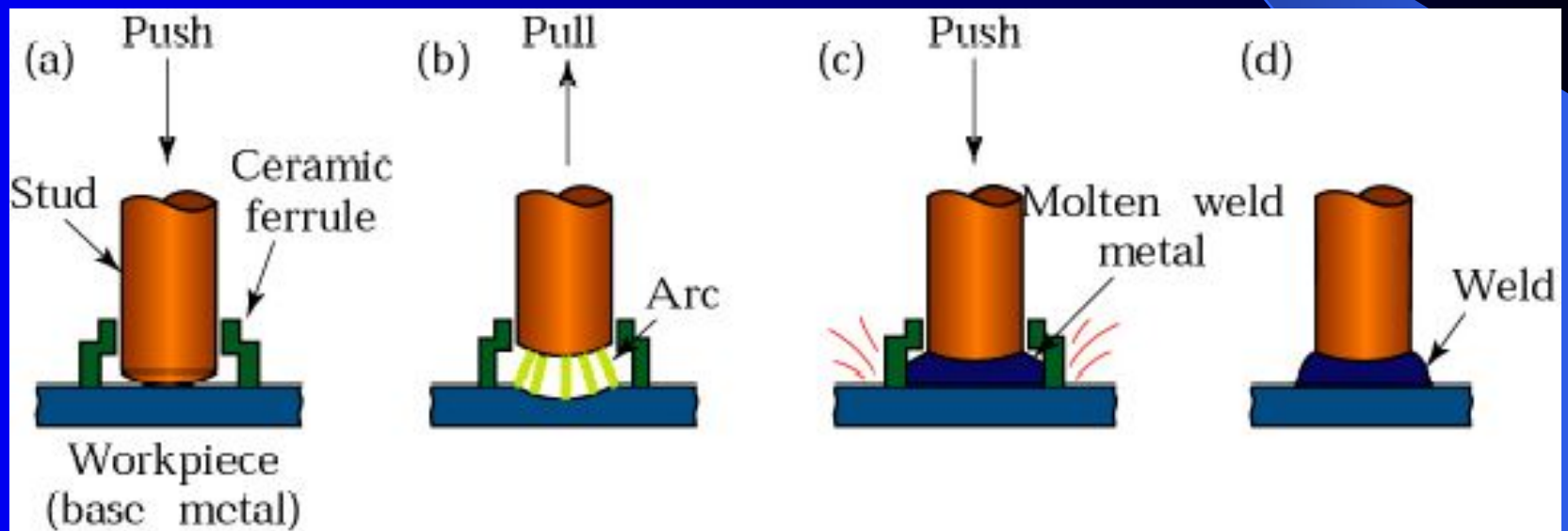


Fig: The sequence of operation in stud welding, which is used for welding bars, threaded rods, and various fasteners onto metal plates.

THE END

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