

# MAJOR MANUFACTURING PROCESSES

- CASTING
- FORMING
- JOINING

## SECONDARY MANUFACTURING METHODS

- MACHINING AND GRINDING

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- MACHINING AND GRINDING

- 1
- 2
- 3
- 4
- 5

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Primary Processes

## SECONDARY MANUFACTURING METHODS

- MACHINING AND GRINDING

# CASTING PROCESS





# FORGING (FORMING)



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ong Press Machinery Industry Co., Ltd.

# FORGING (FORMING)



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# MACHINING



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# UNDERWATER WELDING



# JOINING PROCESS

## MECHANICAL BONDING

- temporary
- semi permanent

### Solid state

- cold welding
- friction welding
- diffusion welding

## ATOMIC BONDING

- solid state
- liquid state
- solid / liquid state

### Liquid state

- Electric
- Chemical



## **Electric**

- **Arc welding**
- **Induction welding**
- **Resistance welding**

## **Chemical**

- **Gas welding**
- **thermit welding**

## **Solid/liquid state**

- **brazing**
- **soldering**

**Welding is the joining of two or more pieces  
Of metal by creating atom to atom bonds**

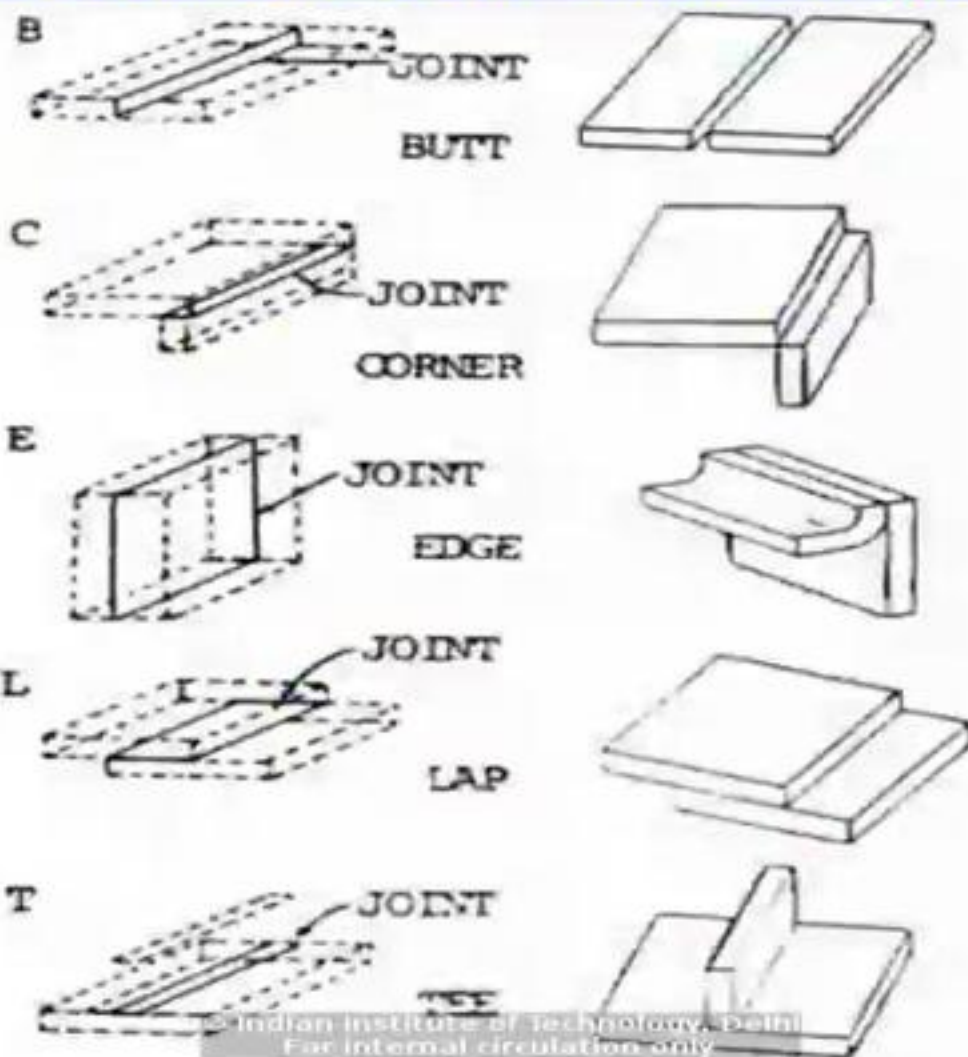
## **Advantages of Welding**

- provides a permanent joint
- welded jt. strength more than parent metal
- can be accomplished on field as well

## **Limitations**

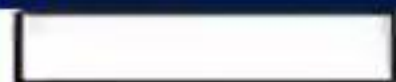
- manual and expensive in terms of labour cost
- involve high energy sources
- welding jt defects substantially reduce strength

# Five basic types of weld joints





## Types of edge preparations needed prior to welding



SQUARE EDGE



BEVEL EDGE



CHAMFER EDGE



J GROOVE EDGE












DOUBLE BEVEL EDGE









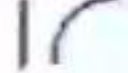
DOUBLE J GROOVE EDGE

Edge prep.  
needed for  
Butt welding  
of sheets  $> 9$  mm






## Different types of welding Symbols in use

FILLET	PLUG OR SLOT	SPOT OR PROJECTION	SEAM	BACK OR BACKING	MELT THRU	SURFACING	FLANGE	
							EDGE	CORNER
								

GROOVE						
SQUARE	V	BEVEL	U	J	FLARE - V	FLARE - BEVEL
						

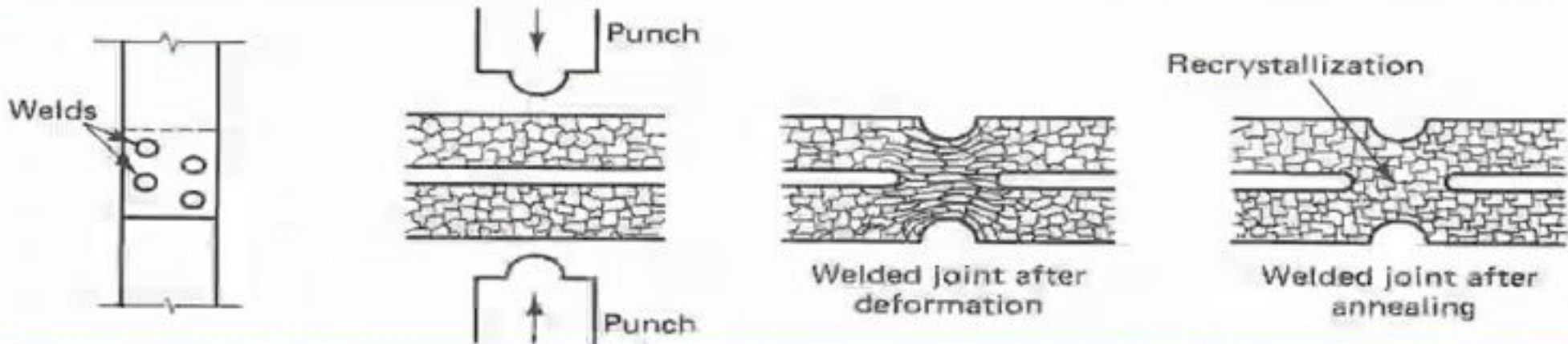
BASIC ARC AND GAS WELD SYMBOLS				
WELD ALL AROUND	FLAG TOWARD TAIL FIELD WELD	CONTOUR		
		FLUSH	CONVEX	CONCAVE
				

SUPPLEMENTARY SYMBOLS
-----------------------

Figure 3-3. Basic and supplementary arc and gas weld symbols.

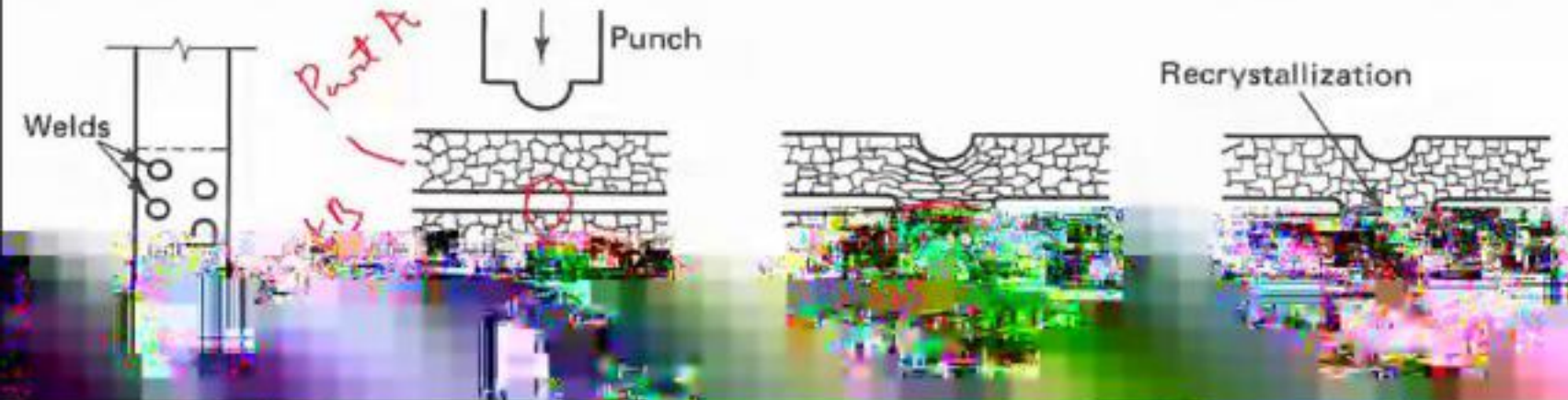
# Cold pressure welding



- **Joining mechanism – plastic deformation**
- **Applications – thin sheets, wires and small electrical components**
- **Normally accomplished by spl. Purpose machine**
- **Effectively used for non ferrous matls especially**
- **Al, Cu, and Al-Cu alloys**
- **Post joining process like annealing and machining may be required**

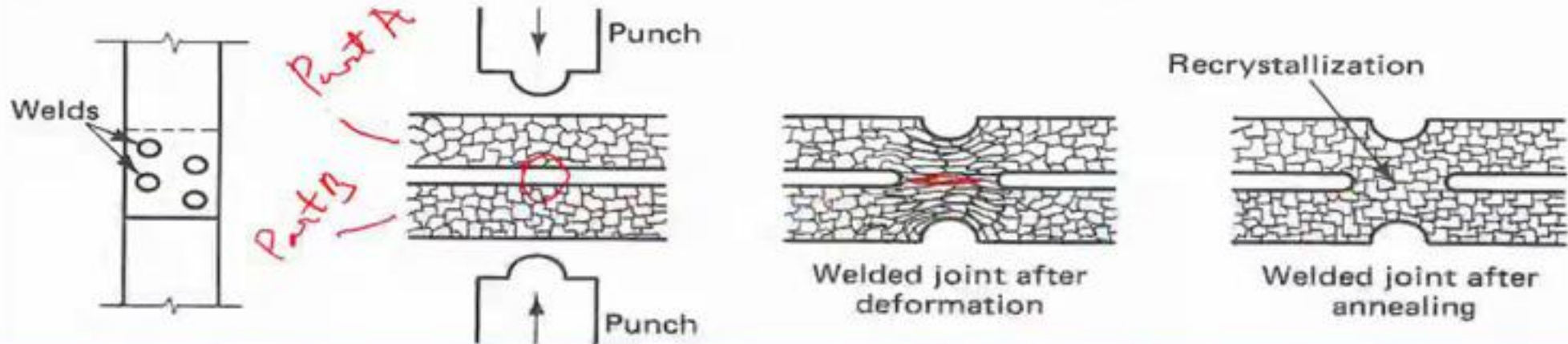


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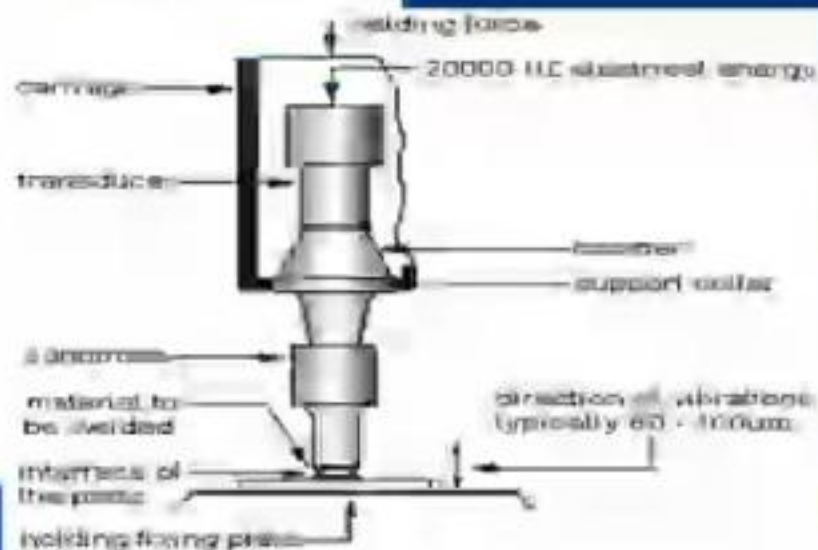
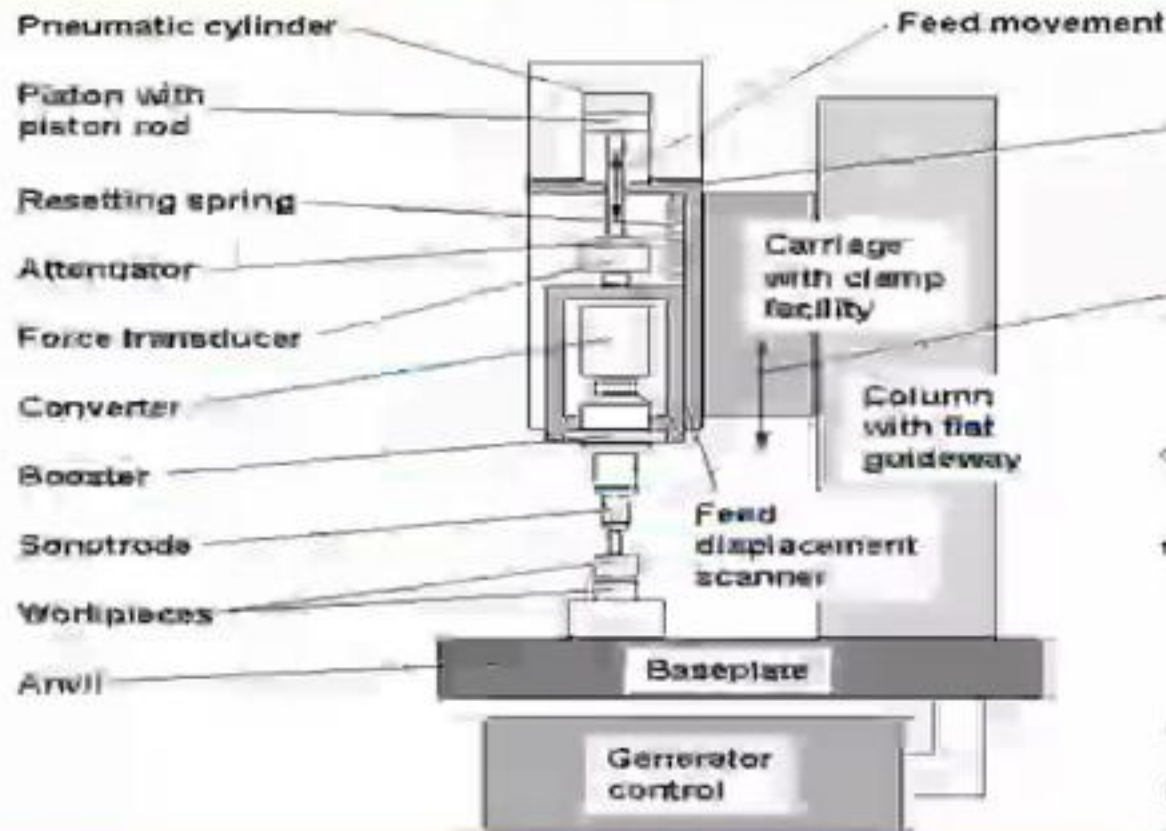


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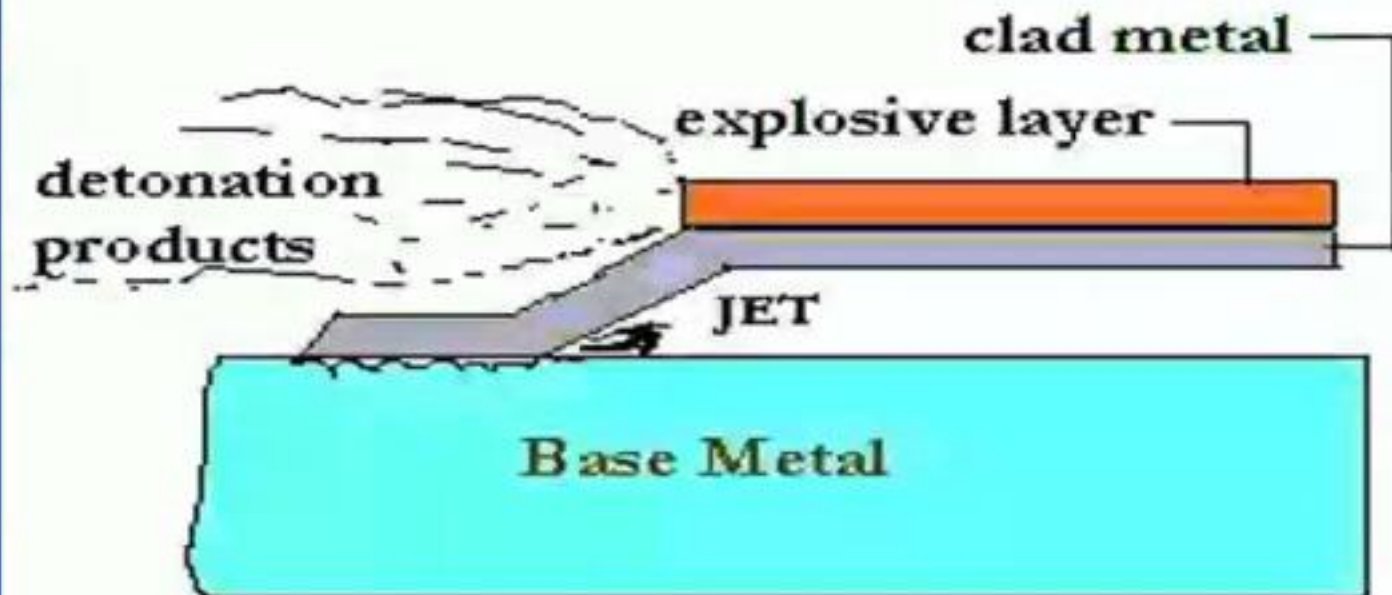
# Ultrasonic Welding

bonding small workpieces in  
electronics, manufacturing  
communication devices,  
medical tools and watches





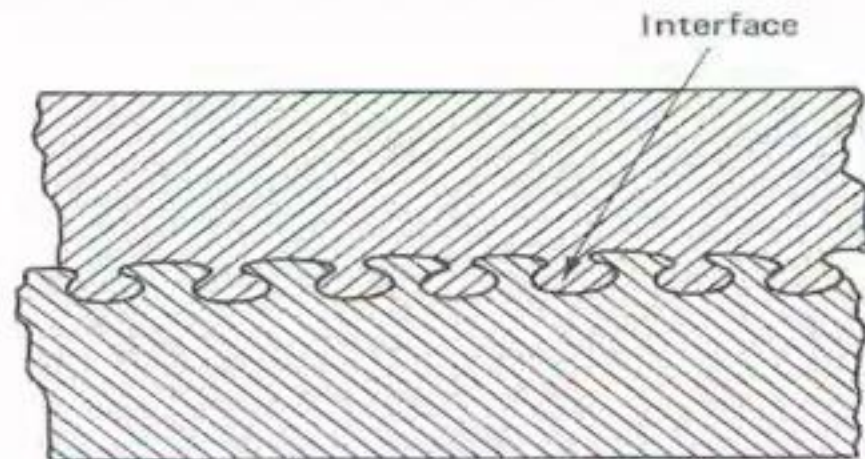
# Explosive welding



**Fig. 1 Explosive Welding**

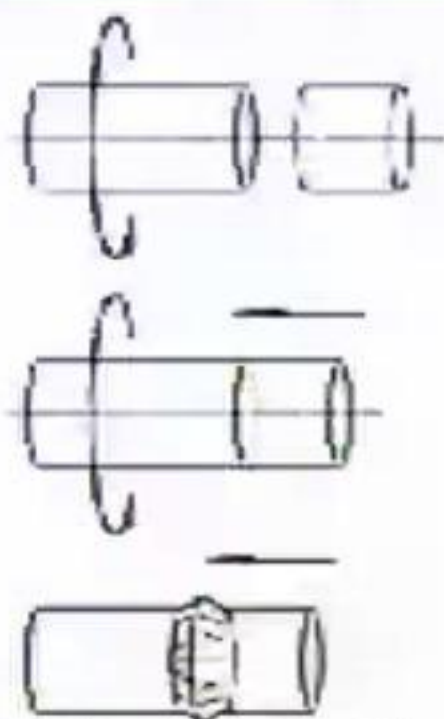
## **Mechanical interlocking produced during Explosive welding**

**It is popular for  
Manufacturing of heat  
Exchangers and  
Chemical processing  
Equipment**



**Limitation of the process is that it cannot be used  
for welding hard, brittle materials**

# Friction Welding



The Friction Welding Process



## Advantages

- high efficiency in terms of energy utilisation
- dissimilar metals can be joined

## Limitations

- one of the two parts to be joined must be a body of revolution
- only forgeable materials can be friction welded



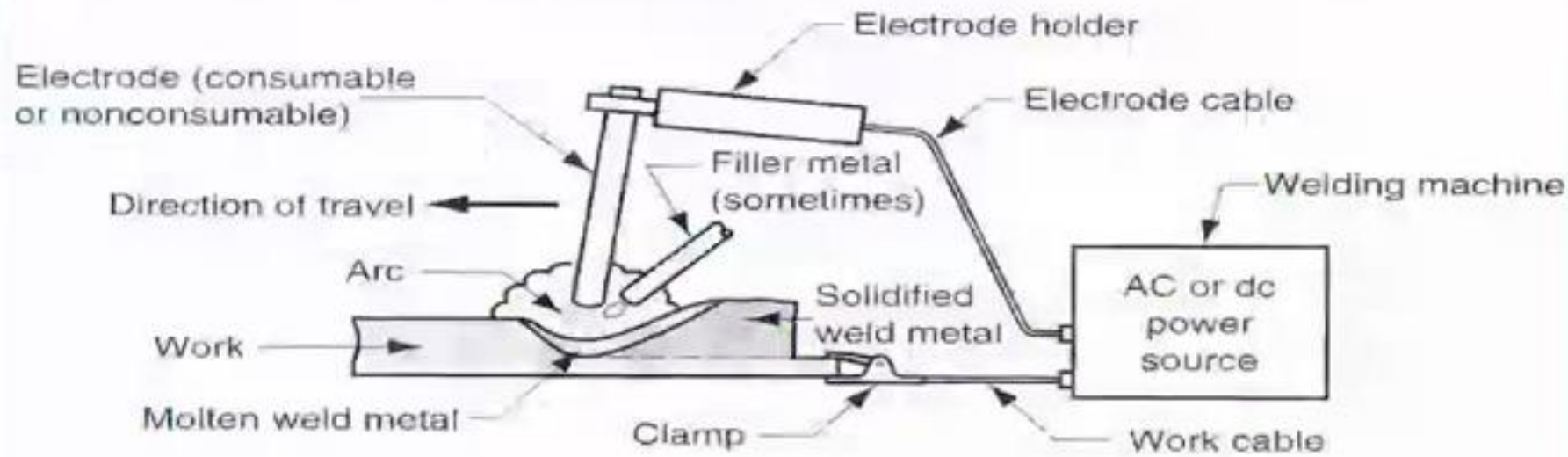
## **Diffusion Welding**

- **Mate the surfaces intimately after cleaning**
- **Keep them together at elevated temperature and appropriate pressure for a long time**
- **mechanism of joining is by diffusion**
- **major process parameters – temp. press., time**
- **Applications – joining of superalloys**
- **Major Advantage – less distortion and residual stresses**

**Pressure applied by dead weight, gas press.  
Heating done by resistance, furnace.**

# Liquid state Welding

## Electric Arc Welding



**Temperature at the centre of the arc  $6000^{\circ}\text{C}$**

**For starting the arc 45 V for DC and upto 60 V for AC**

**Voltage drops to 15 to 30 V after the arc established**

**DCSP electrode is cathode – deposition rate high,**

**Heat penetration low thin sheet metals are welded**



## Different types of Arc Welding Processes

- Shielded Metal Arc Welding (SMAW)
- Submerged Arc Welding (SAW)
- Gas Metal Arc Welding (GMAW)
- Gas Tungsten Arc Welding (GTAW)
- Plasma Arc Welding (PAW)
- Carbon Arc Welding
- Flux cored Arc Welding

### Electrodes used in Arc Welding

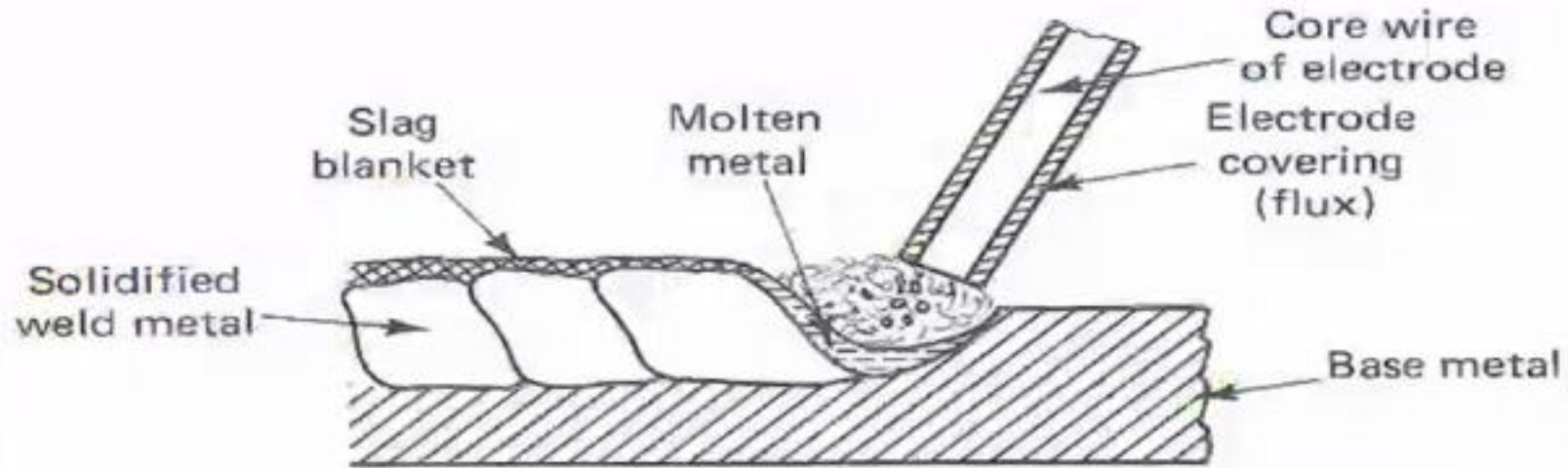
- Consumable
- Non consumable

#### Consumable

- Bare
- coated

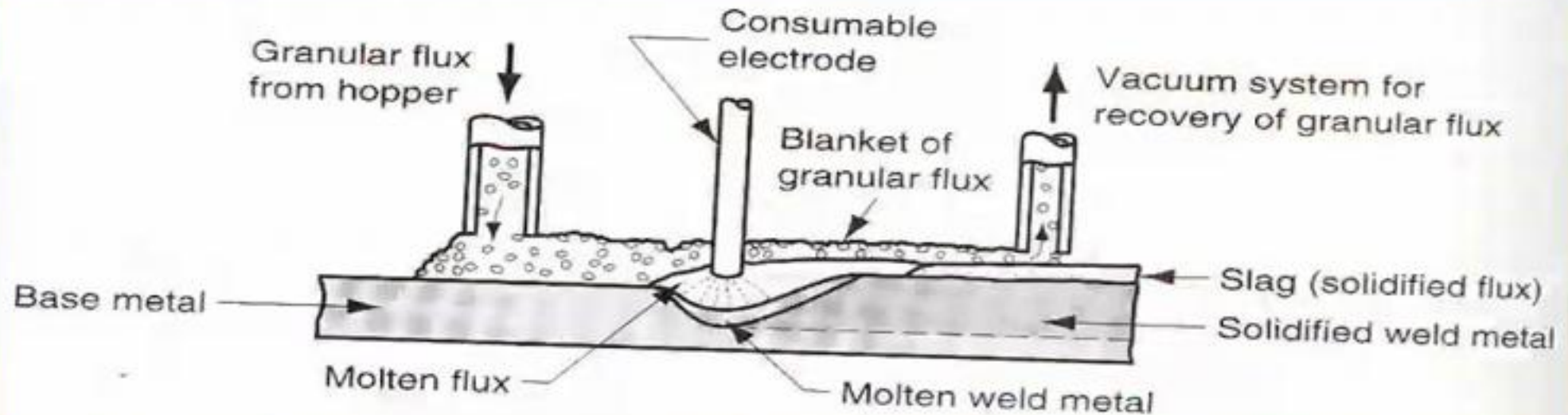


# SMAW



- Coated consumable electrode used
- The coating melts to provide a protective atmosphere and slag for the welding operation
- Current 30 to 300 amps at 15 to 45 V
- used for carbon steels, low alloy steels, CI
- Advantages are better weld quality, arc stability

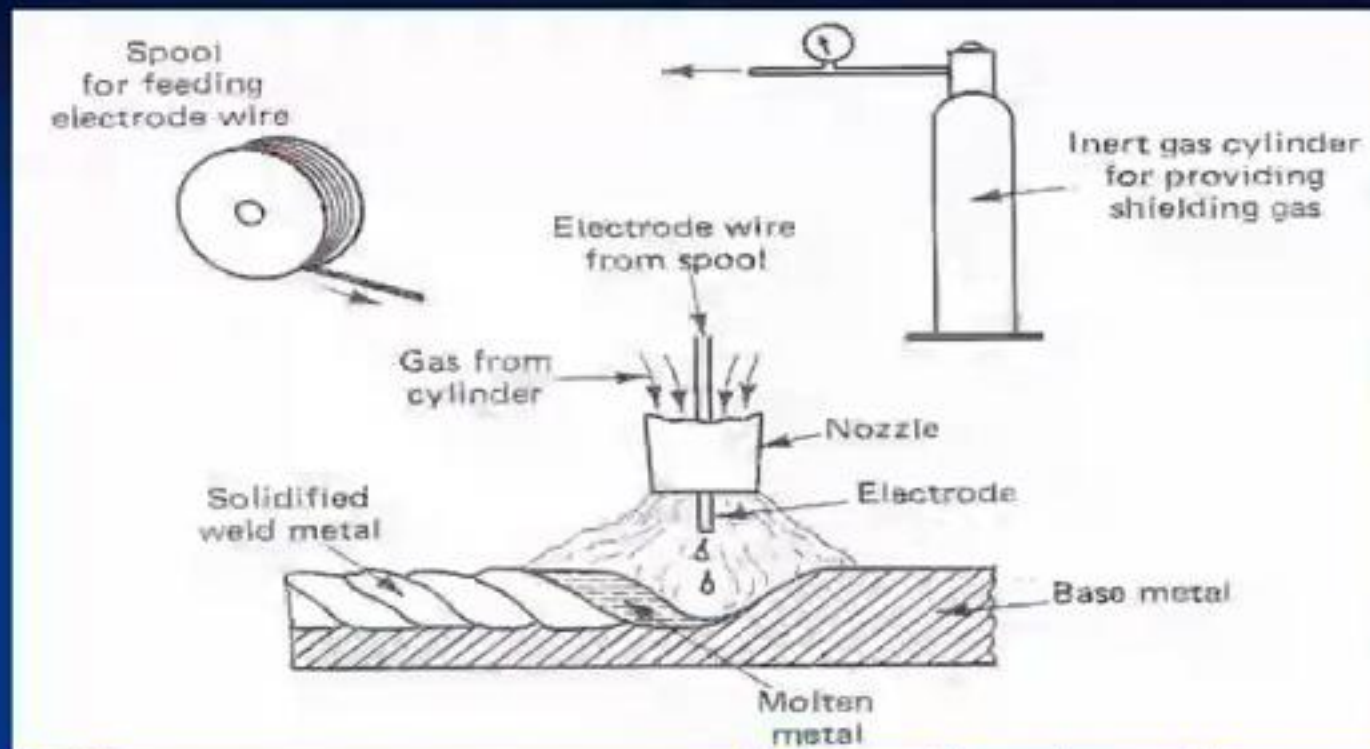
# SAW



- Automatic process, weld area shielded by fusible granular flux
- The flux forms a glass like slag which protects the weld joint
- Currents used 3000 to 4000 amps
- high welding rate, high weld quality, deeper penet.



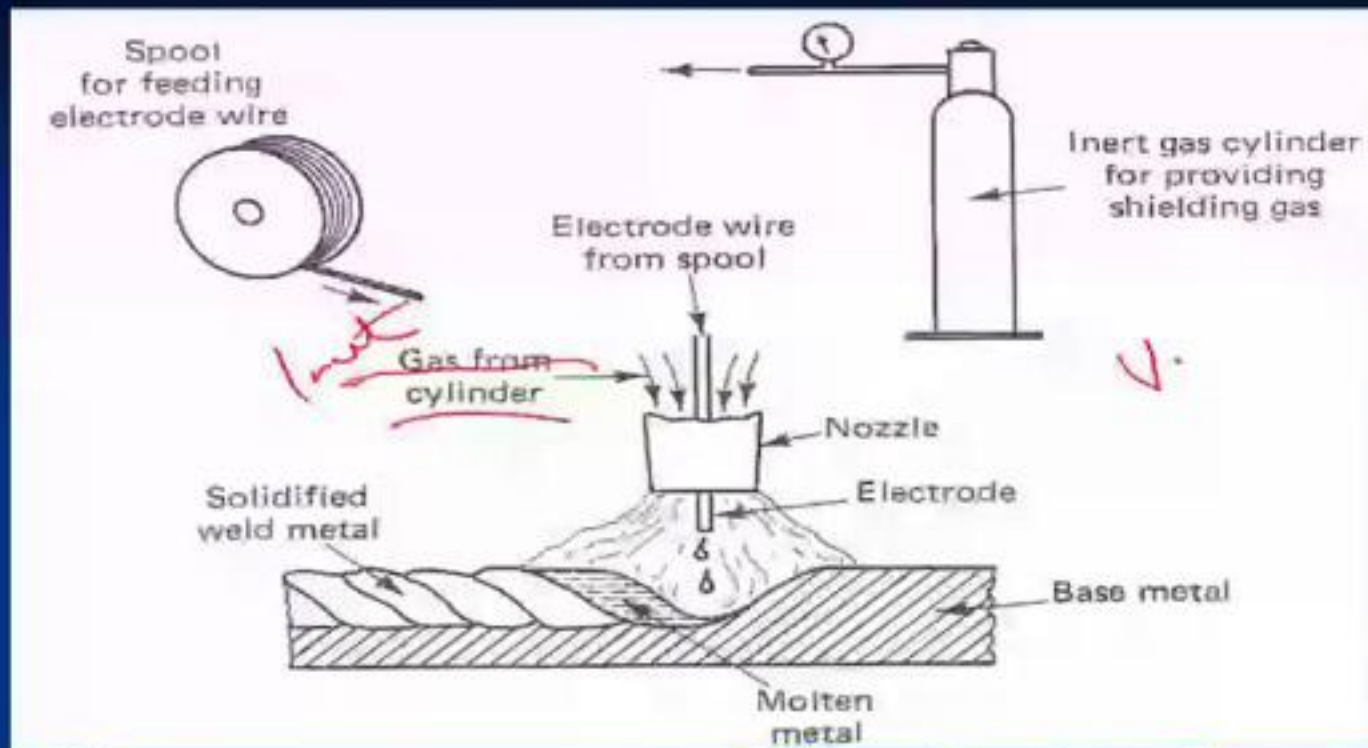
# GMAW (MIG)



- solid continuous consumable electrode used
- Argon, He, Nitrogen,  $\text{CO}_2$  used as shielding gas
- For welding Al alloys, stainless steels, Ar/He is used
- For low and medium carbon steels  $\text{CO}_2$  is used
- Process is automatic, higher depos. rate than SMAW

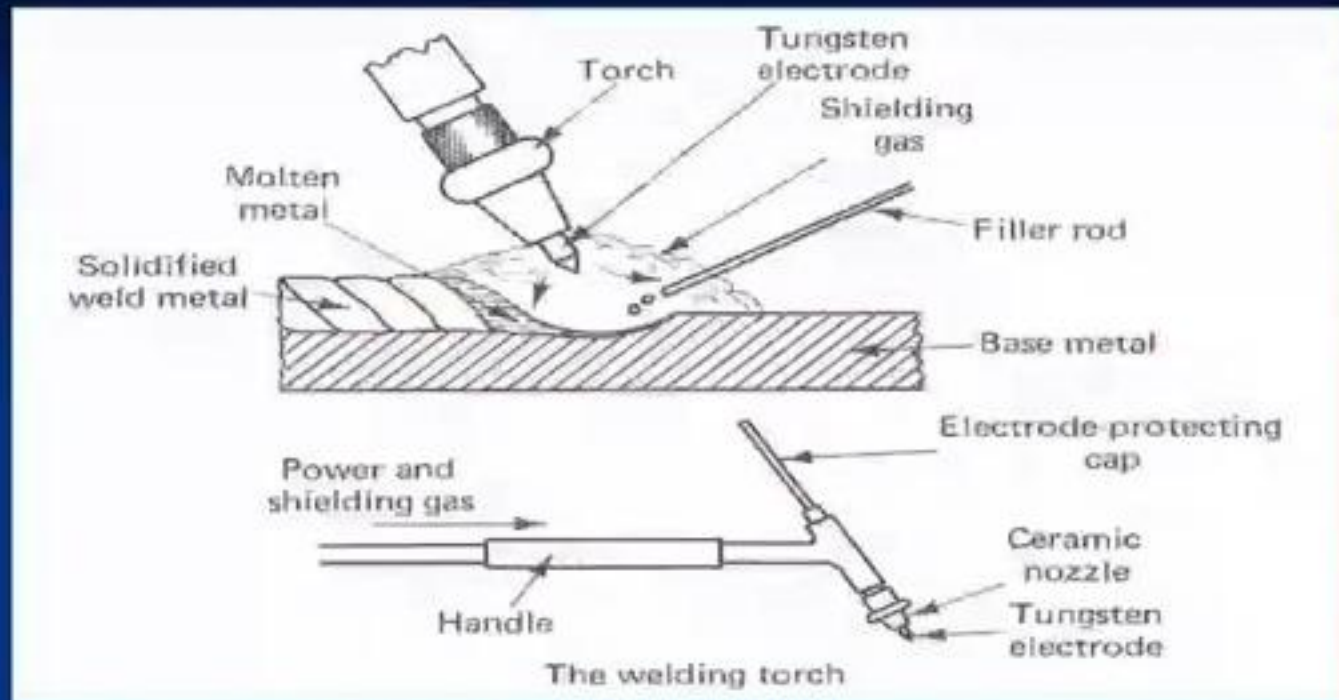


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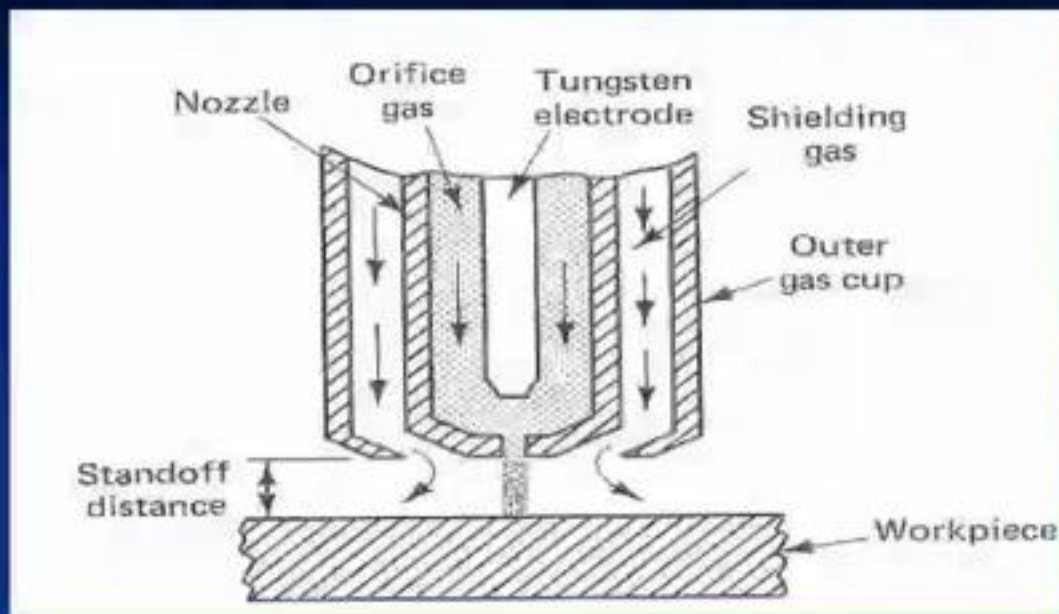
# GTAW (TIG)



- **Non consumable electrode & inert gas for shielding**
- **can be used to weld all types of engg. Matls.**
- **Thin sheets of Al, Mg alloys welded by DCRP**
- **DCSP used for steels, copper & Ni alloys**
- **All types of joints can be produced**



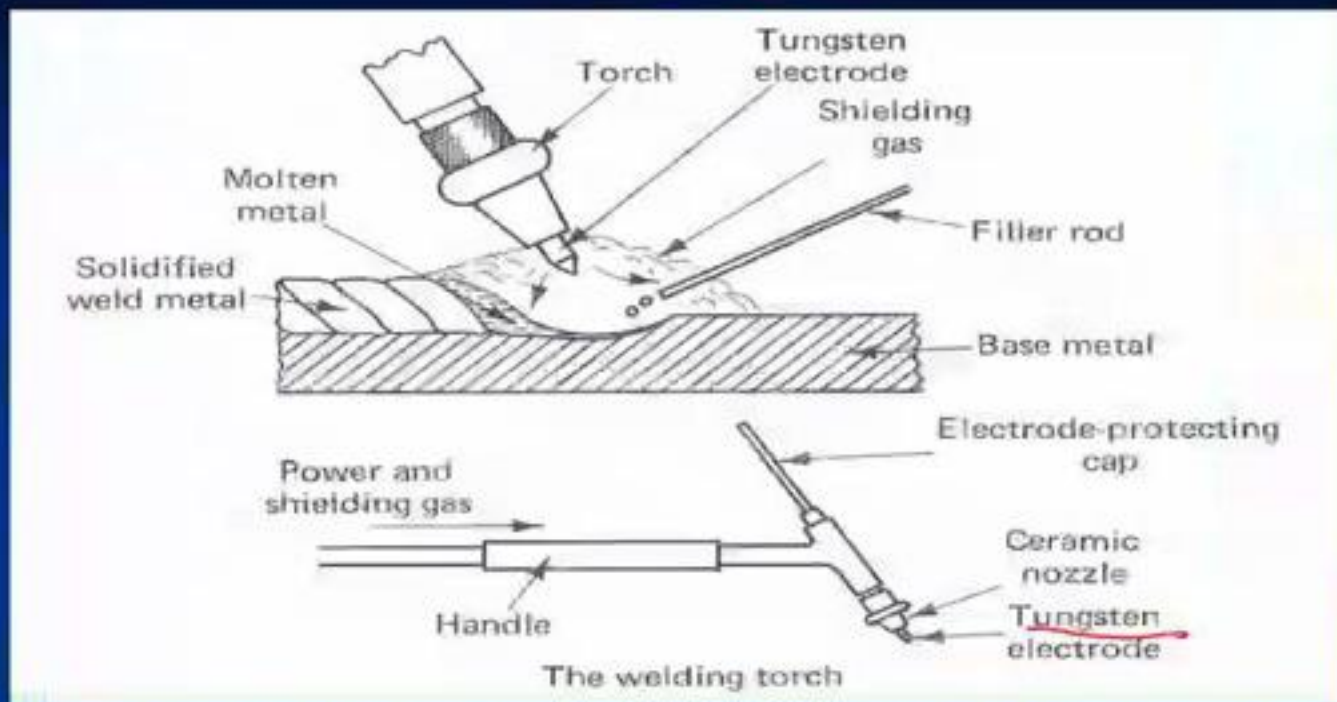
# PAW



- Special type of GTAW where a plasma arc is directed at the weld area
- Arc can be transferred / non transferred type
- Advts are arc stability, better penetration control high travel speeds, excellent weld quality
- major limitation is high equipment cost

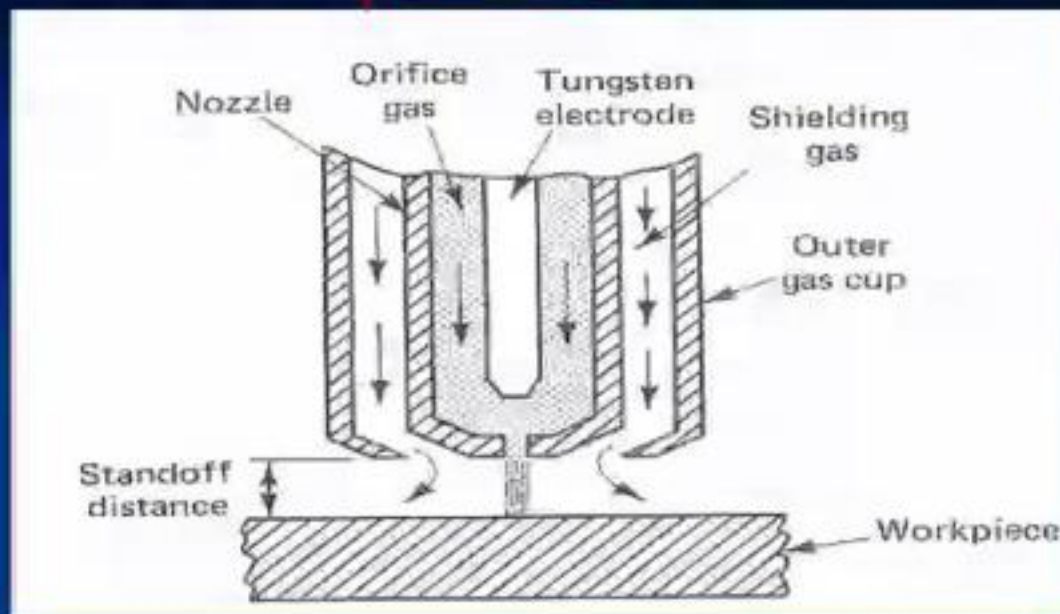


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## **Resistance Welding Process**

**It is a fusion welding process that utilizes a Combination of heat and pressure to accomplish Coalescence.**

**Current used is very high 5000 to 20,000 amps, Voltage is low (10 V), time duration is small(0.1-0.4s)**

**Functions of pressure are**

- 1. To ensure contact between electrodes and work**
- 2. To press the surfaces when welding temp reached**

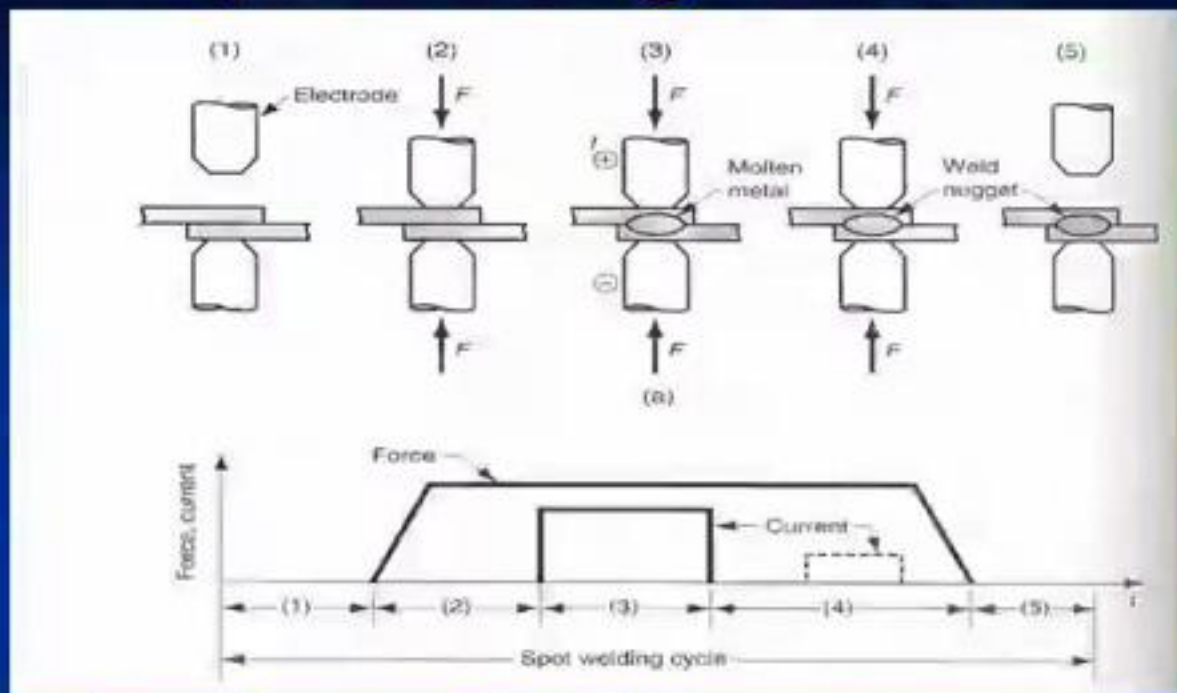
**Electrode materials are generally Cu or Cu alloys**

**Desirable properties are**

- high electrical conductivity**
- high hardness**



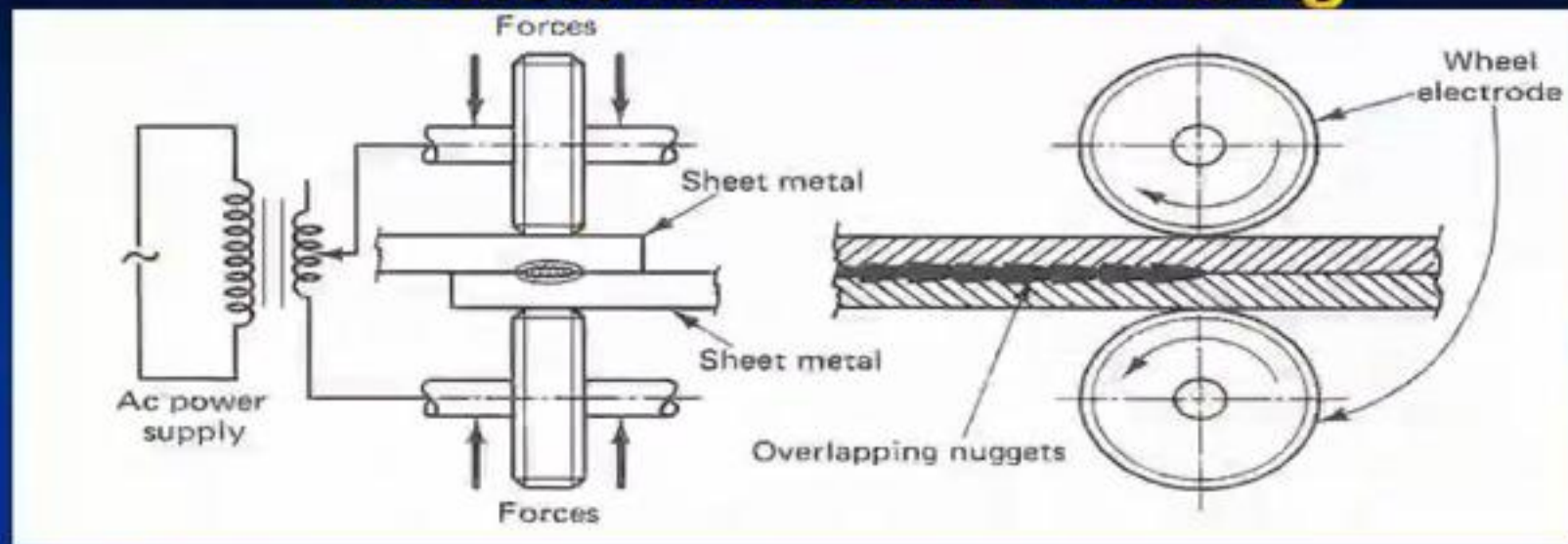
# Spot Welding Process



## Application of RSW

- In automobile manufacturing unit
- In manufacture of various appliances
- In metal furniture making
- Other products made out of sheet metal

# Resistance Seam Welding



## Advantages

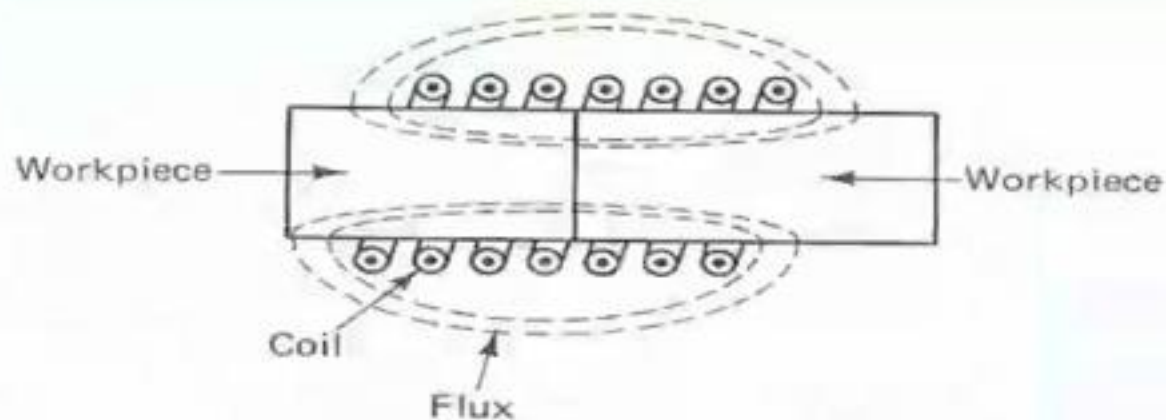
- Low cost
- High production rates
- Suitable for automation

## Limitations

Well designed fixture necessary  
Sheets of thickness upto 4 mm  
of carbon steel cannot be seam  
welded because of the  
requirement of high amperage



## Induction Welding



High frequency current in the range of 10 kHz to 300 kHz. The primary source of heat is the eddy current induced into the workpiece.

An important phenomenon in induction welding is the "skin effect". This refers to the fact that electric current flows superficially. The penetration can be effectively controlled by proper choice of frequency.

Industrial application include butt welding of pipes and continuous seam welding of tubes.



## **Gas Welding Process**

**Oxyacetylene flame welding**

**Flame temperature around 3150°C**

**Neutral, reducing and oxidising flames**

**Reducing flame employed in welding CI**

**Oxidising flame employed in welding brass, bronze**

**The flame has three distinct zones**

- Inner cone having higher temp.**
- acetylene feather of temp around 2000°C**
- Outer envelope 1250°C**

## Thermit Welding

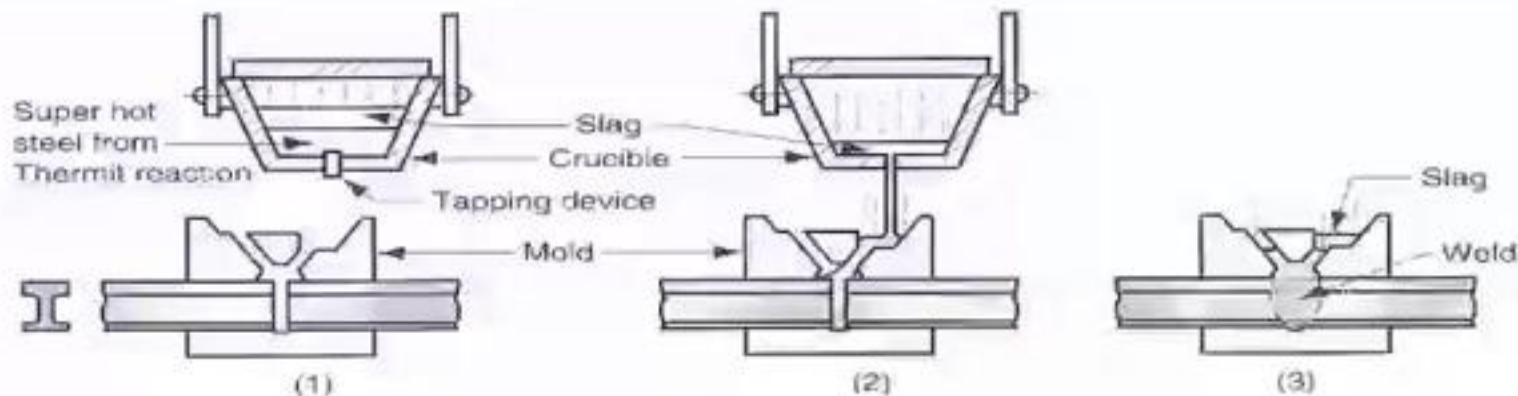


FIGURE 29.25 Thermit welding: (1) thermite ignited; (2) crucible tapped, superheated metal flows into mold; and (3) metal solidifies to produce weld joint.

**A mixture of fine alumina and iron oxide mixed  
In the ratio 1:3. Temp. achievable 3000°C**

**$8\text{Al} + 3\text{Fe}_3\text{O}_4 = 9\text{Fe} + 4\text{Al}_2\text{O}_3 + \text{heat}$**

**Reaction time is around 30 s**

**It is used in joining railroad rails, pipes and in  
Repairing heavy castings No finishing reqd.**



## **Welding Defects**

### **WARPAGE:**

**Caused due to the residual stresses in the longitudinal as well as transverse direction of the welded assembly**

**Can be minimized by**

- **Preheating the workpiece**
- **Proper welding fixtures**
- **Tack welding**
- **Proper welding conditions**
- **Stress relief heat treatment of the welded assembly**
- **Proper design of the weld joint**



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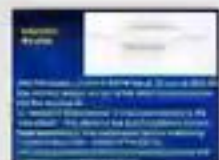
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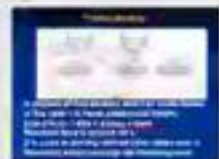
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## Welding Defects

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