Radiant Energy Welding Processes

- These type are also called ‘newer’ since these are not in used for many years and have been developed very recently. The types are

1. Electron beam welding
2. Laser beam welding

Electron beam welding

- Electron beam welding is a process in which the heat is generated when the electron beam impinges on work piece. As the high velocity electron beam strikes the surfaces to be welded, their kinetic energy changes to thermal energy and hence causes the workpiece metal to melt and fuse.
- The beam is created in a high vacuum (10^{-3} to 10^{-5} mm of hg)
- This process employs an electron gun in which the cathode in form of hot filament of tungsten or tantalum is the source of a stream of electrons.
- The electrons emitted from filament accelerated to a high velocity to the anode because of the large potential difference that exists between them.
- The electron beam is focused by a magnetic lens system on the workpiece to be welded.

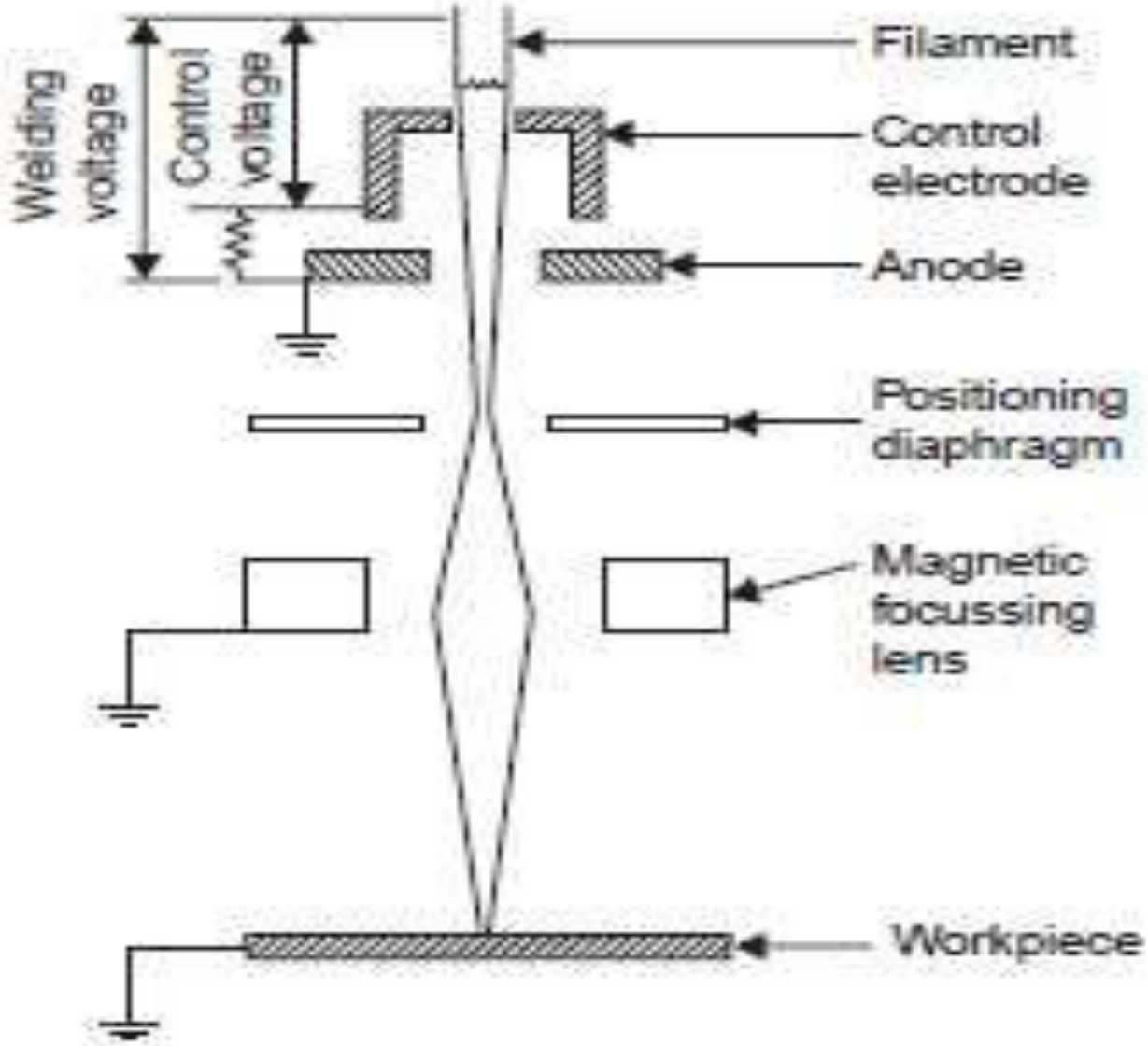


Fig. Principle of electron beam welding

- The depth of penetration of the weld depends on the electron speed which in turn is dependent upon the accelerating voltage.

- When the high velocity electron beam strikes the work-piece all the kinetic energy is converted to heat.

- As these electrons penetrate the metal, the material that is directly in the path is melted which when solidifies form the joint.

Advantages

- The penetration of the beam is high.
- The process can be used at higher welding speeds typically between 125 and 200 mm/sec.
- No filler metal or flux needs to be used in this process.
- The heat liberated is in a narrow zone, thus the heat affected zone is minimal as well as weld distortions are virtually eliminated.
- It can weld or cut any metal or ceramic, diamond, sometimes as thick as 150 mm.

Disadvantages

- High operating cost
- Expensive equipment
- Work size is limited by the size of the chamber.

Application

- Automobile, airplane, aerospace, farm and other type of equipment are being welded by the electron beam process.

Laser Beam Welding

- Laser is a abbreviation of light amplification by stimulated emission of radiation.
- The laser beam welding process is the focusing of a monochromatic light into extremely concentrated beams.
- It employs a carefully focused beam of light that concentrates tremendous amount of energy on a small area to produce fusion.
- The laser beam welding consist of electrical storage unit, capacitor tank , triggering device , flash tube wrapped with a wire , focusing lens mechanism and work table.

- When capacitor bank is triggered, energy is injected into the wire that surrounds the flash tube.

- The flash tube or lamp are designed for the operation at a rate of thousand of flashes per second.

- The lamp become a efficient device for converting electrical energy into light energy, the process of pumping the laser. The laser is then activated.

- The beam is emitted through the coated end of the lasing material.

- The beam goes through a focusing device where it is pin-pointed on the workpiece. Fusion takes place and the weld is accomplished.

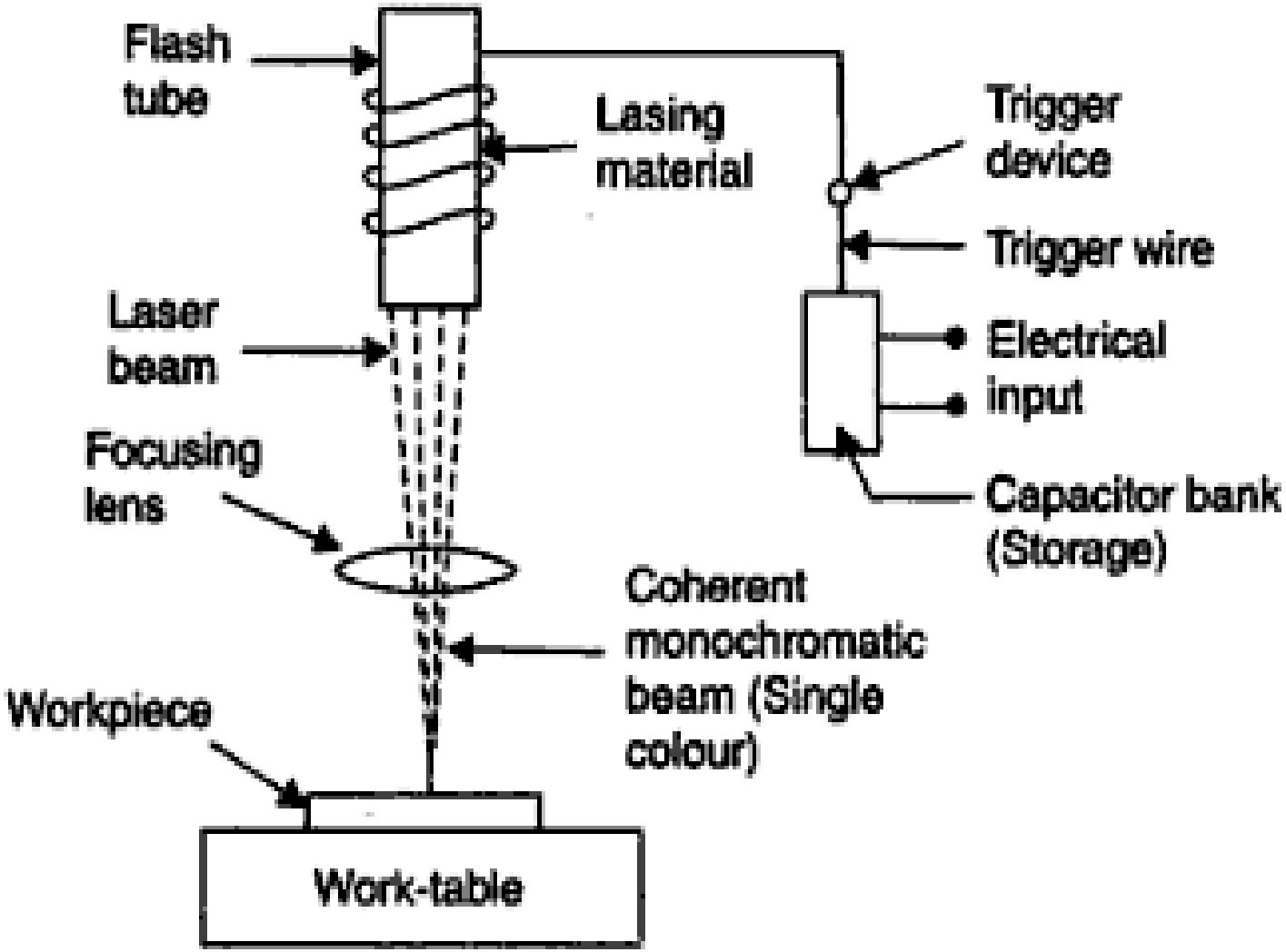


Fig. Laser beam welding.

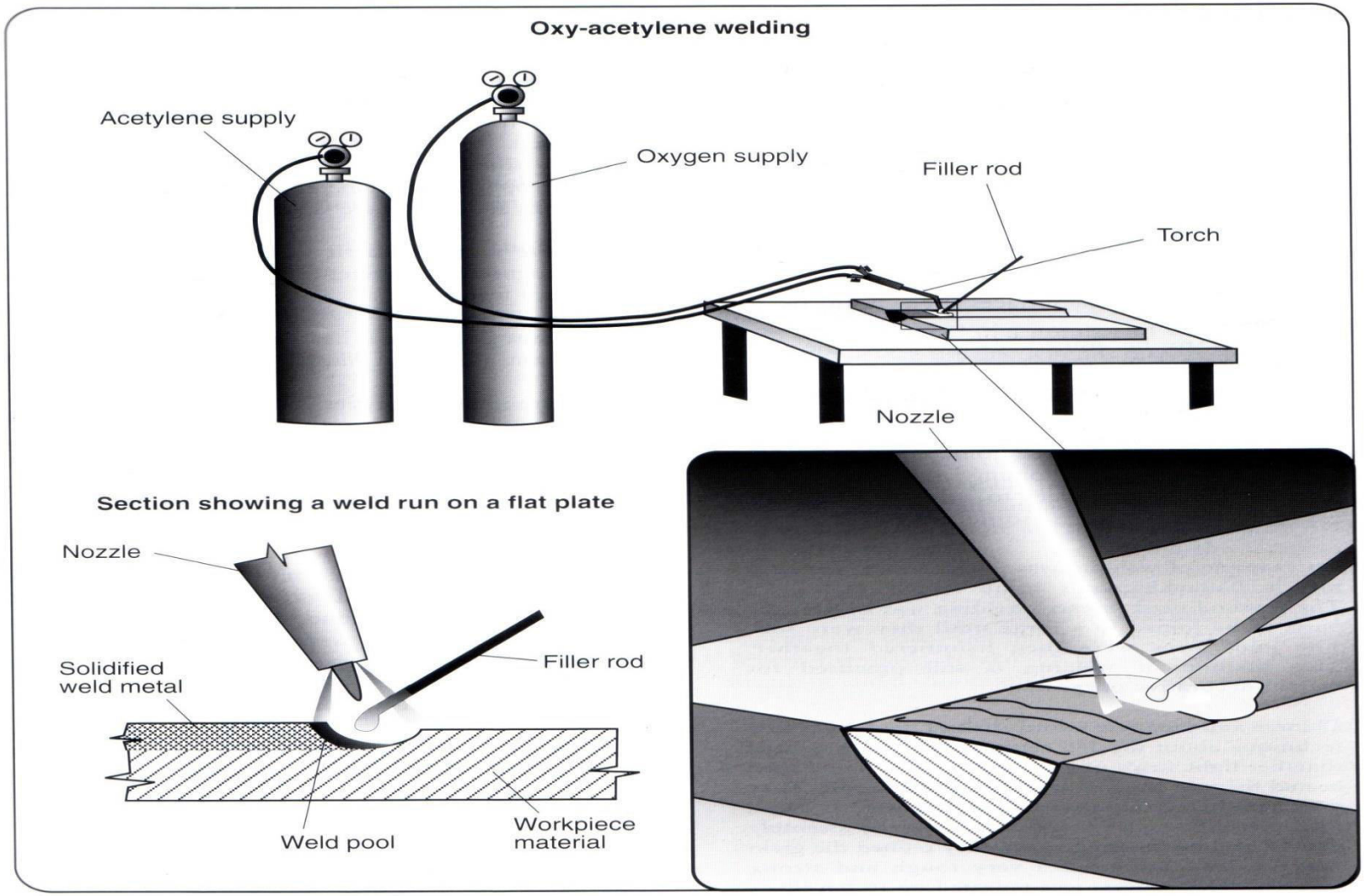
Advantages

- This process can be used to weld dissimilar metals with widely varying physical properties.
- Laser welding holds thermal distortion and shrinkage to a minimum.
- High production rate.
- Weld can be made with a high degree of precision.

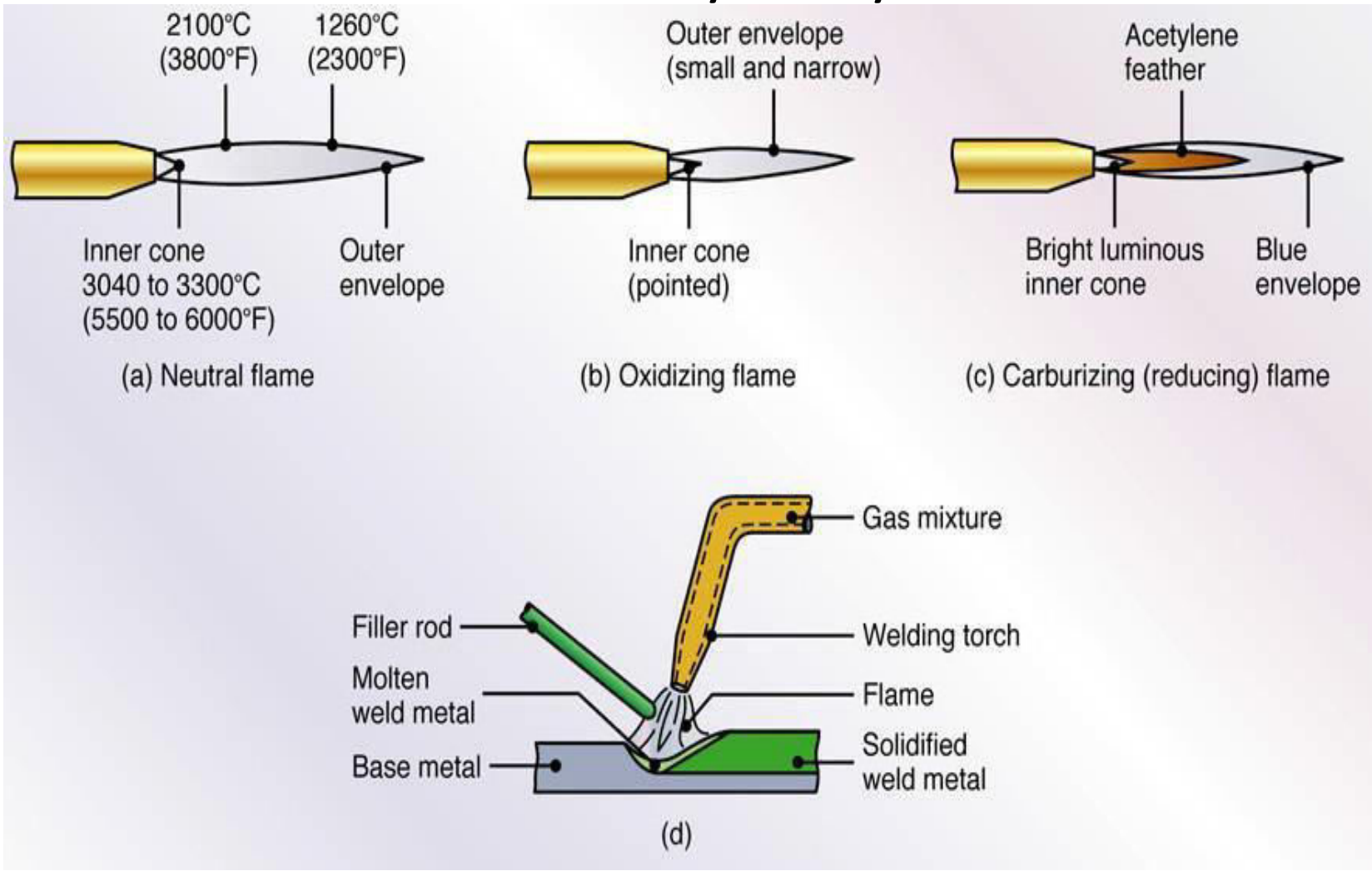
Disadvantages

- High energy losses.
- Highly skilled operation.
- High equipment cost.
- Eye protection required.

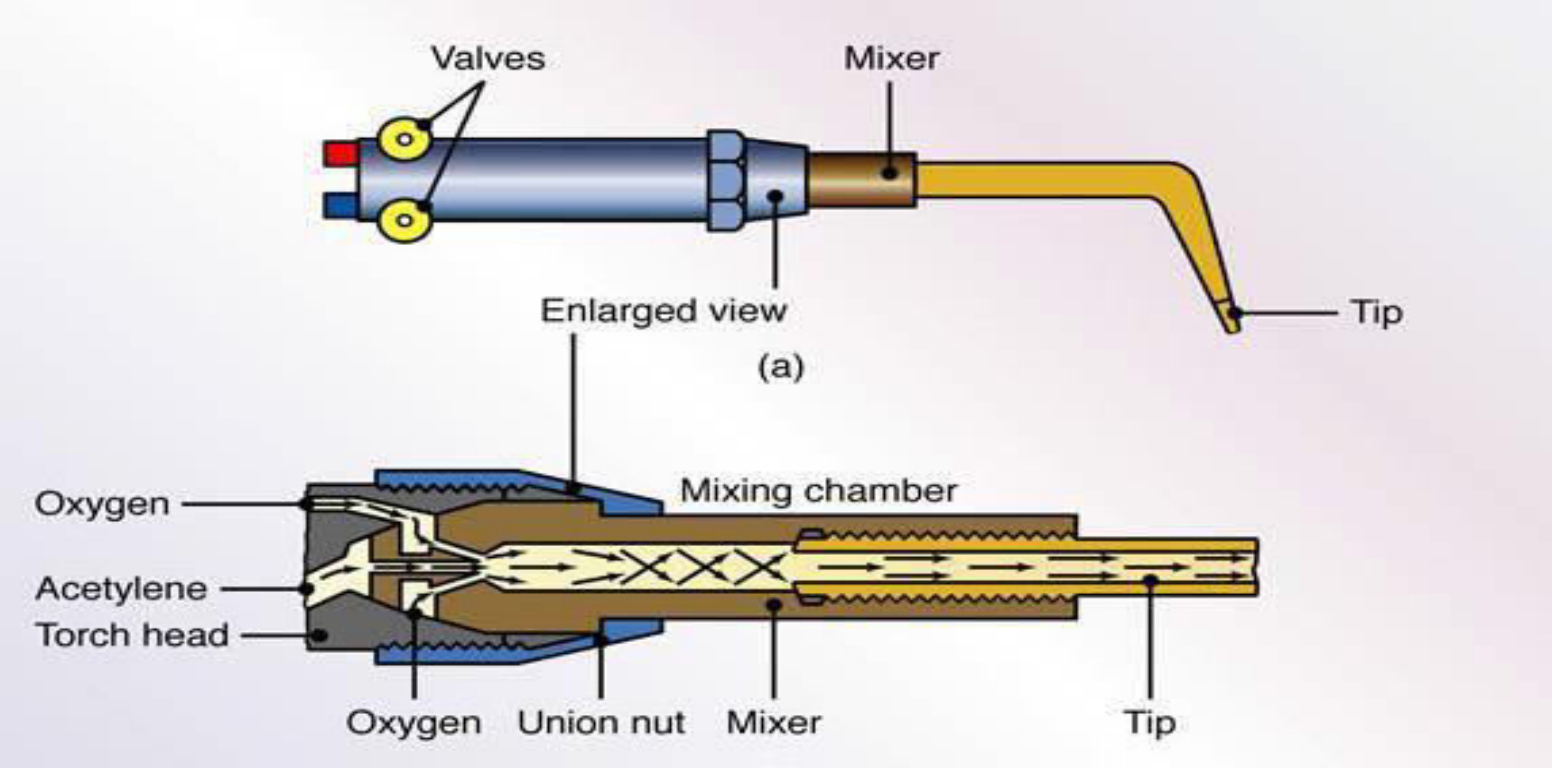
Gas Welding


Oxy-acetylene welding
Acetylene supply
Oxygen supply
Filler rod
Torch
Nozzle
Section showing a weld run on a flat plate
Nozzle
Filler rod
Solidified weld metal
Weld pool
Workpiece material

Oxy-acetylene flames



Typical torch styles:-



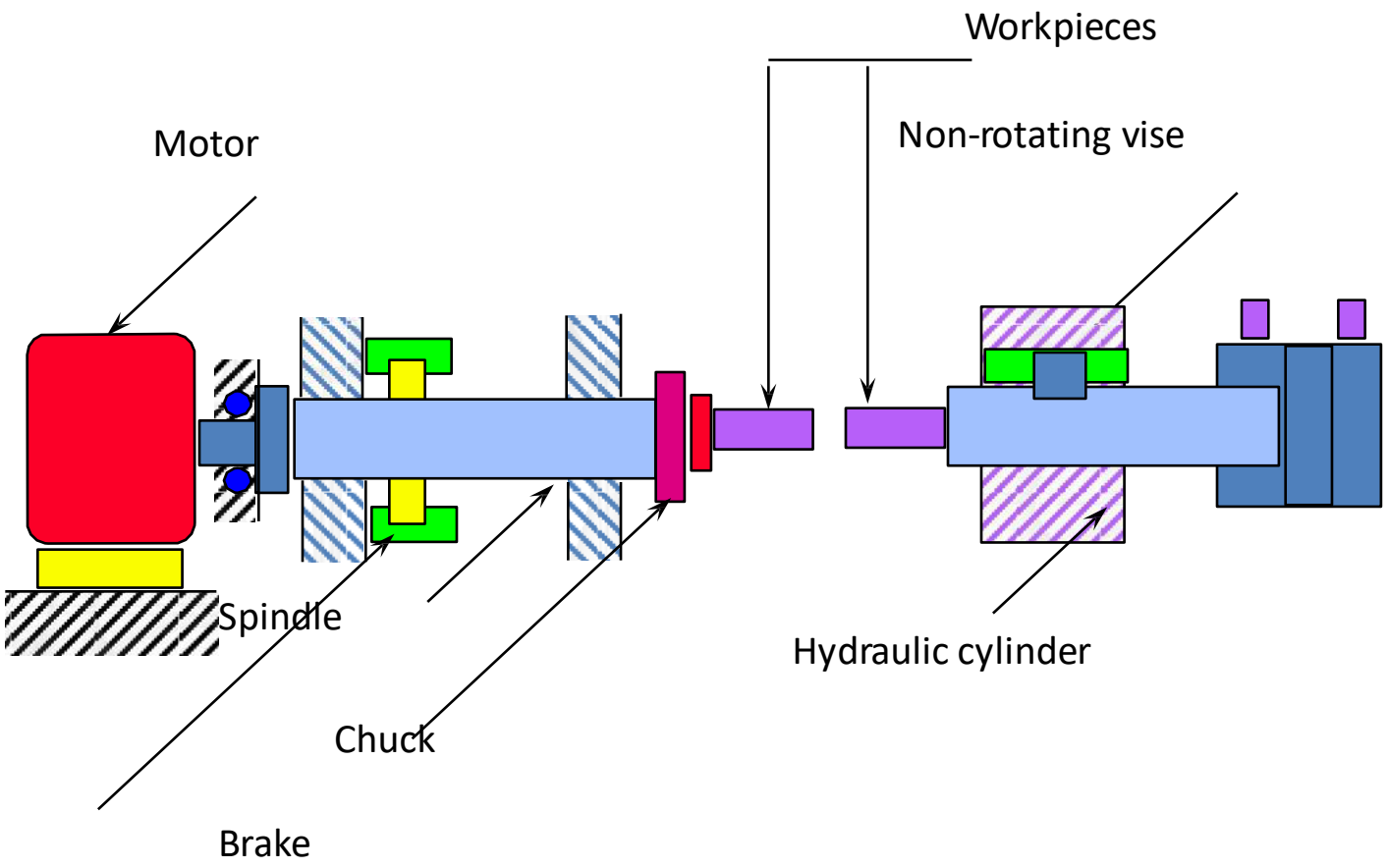
Friction welding

-Friction heat caused by the motion of one surface against another enables plastic deformation and atomic diffusion at the interface

-Used by the automotive industry for decades in the manufacture of a range of components

-The weld is formed across the entire cross-sectional area of the interface in a single shot process

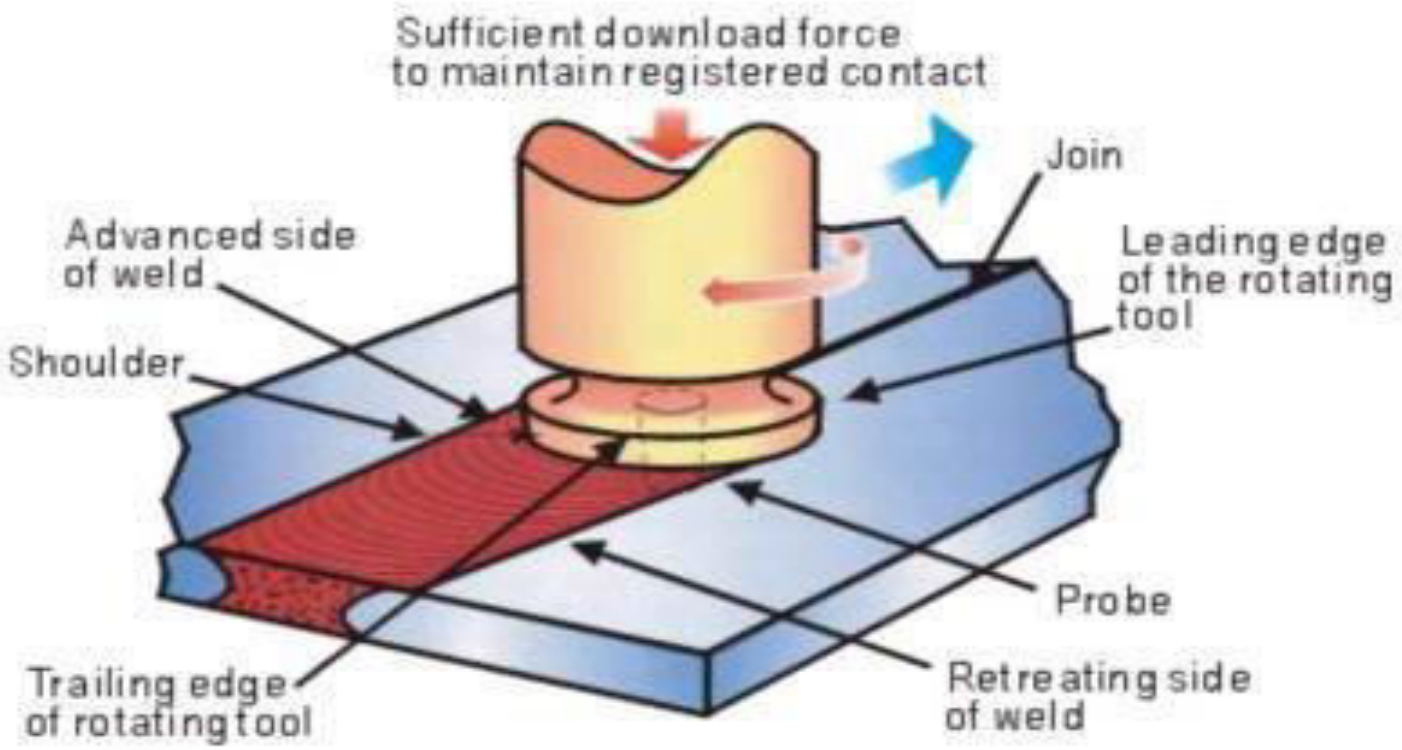
Friction welding



Advantages of friction welding

- Narrow HAZ
- Dissimilar metals can be joined
- No fusion zone
- Can be used under water
- very high reproducibility - an essential requirement for a mass production industry
- Excellent weld quality, with none of the porosity that can arise in fusion welding
- environmentally friendly, because no fumes or spatter are generated, and there is no arc glare or reflected laser beams with which to contend

Friction surface / Friction stir welding



Steps in friction stir welding

- A non-consumable rotating tool is pushed into the materials to be welded and then the central pin, or probe, followed by the shoulder, is brought into contact with the two parts to be joined.
- The rotation of the tool heats up and plasticises the materials it is in contact with and, as the tool moves along the joint line, material from the front of the tool is swept around this plasticised annulus to the rear, so eliminating the interface.

DEFINITION OF WELDABILITY

- Two metallic parts of same or different metals mixed and fused when welded with or without applying pressure, with or without use of filler metal then the ease with wich the metal joint will properly of joining metal or metals called weldability

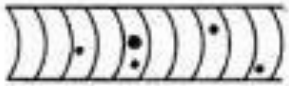
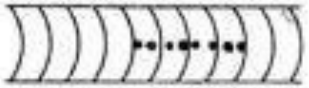
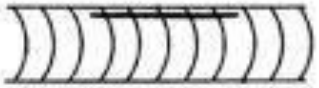
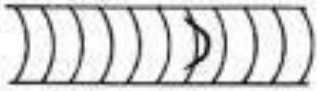
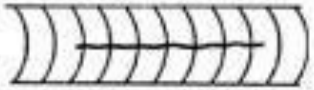
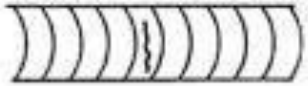
- The easy with which welding of a give material can be done without producing any defect is called weldability.

- Also be defined as the capability of a metal to be welded under the fabrication conditions imposed satisfactorily in the intended surface.

TYPES OF DEFECTS

- Slag Inclusion
- Undercut
- Porosity
- Incomplete fusion
- Overlap
- Underfill
- Spatter
- Excessive Convexity
- Excessive Weld Reinforcement
- Incomplete Penetration
- Excessive Penetration

Defects	Probable cause	Remedy
1. Porous welds	a. Short arc	Hold longer arc. Use proper electrode.
	b. Insufficient puddling time	Allow sufficient puddling time for gases to escape.
	c. Impaired base metal	Remove impurities in base metal.
	d. Incorrect current	Use proper current.
	e. Improper welding technique	Use weaving motion to eliminate pin holes.
2. Incomplete penetration	a. Speed too fast	Weld slowly enough to get good root penetration.
	b. Electrode too large	Select electrode according to welding groove size.
	c. Current too low	Use sufficient current.
	d. Faulty preparation	Calculate electrode penetration properly. Leave proper free space at bottom of weld.
3. Warping	a. Shrinkage of weld metal	Use intermittent welds. Control cooling.
	b. Faulty clamping of parts	Clamp parts properly.
	c. Faulty preparation	Peen joint edges before welding. Space parts properly.
	d. Overheating at joints	Increase travel speed. Use high speed, moderate penetration electrodes.
4. Poor fusion	a. Incorrect speed	Use correct speed.
	b. Current improperly adjusted	Use proper current to allow deposition and penetration.
	c. Faulty preparation	Use proper cleaning, edge preparation, and positioning.
5. Poor fusion	a. Improper electrode size	Select proper electrode.
	b. Improper welding technique	Weave must be sufficient to meld sides of joint. Prevent weld metal from curling away from plates.

Description	Cross-section of weld	Radiogram
Worm hole		
Linear Slag Inclusion - |		
Gas Pore		
Porosity (Linear)		
Lack of side-wall fusion - (lack of root fusion)		
Lack of inter-run fusion		
Longitudinal Crack		
Traverse Crack		
Radiating Cracks