Tool Design for Joining Processes

ITCD – 301-001

Types of joining processes

- Physical
- Application of heat
- Application of pressure
- Both heat and pressure
- Mechanical
- Does not involve changes in composition
- Edges remain distinct

Tooling in joining

- Hold the parts in correct relationship
- Assist and control the joining process
- Mechanically or physically
- Alignment of workpieces
- Physical joining requires tooling
- High temperature makes manual positioning impractical
- Tooling for hot processes should withstand heat and accelerate or retard flow of heat
- Hot fixtures should have thermal expansion coefficient so that it remains functional

Welding Fixtures

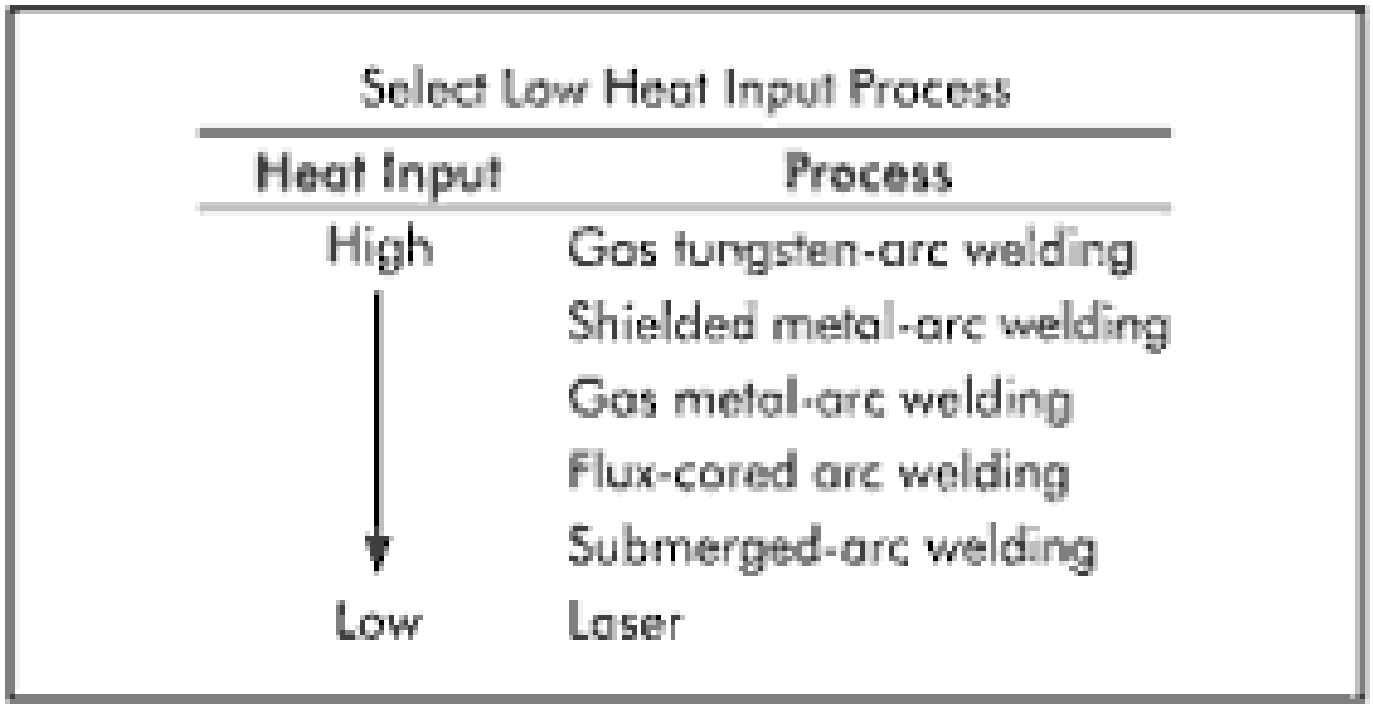


Figure 10-1. *Degree of heat input based on process.*

Distortion

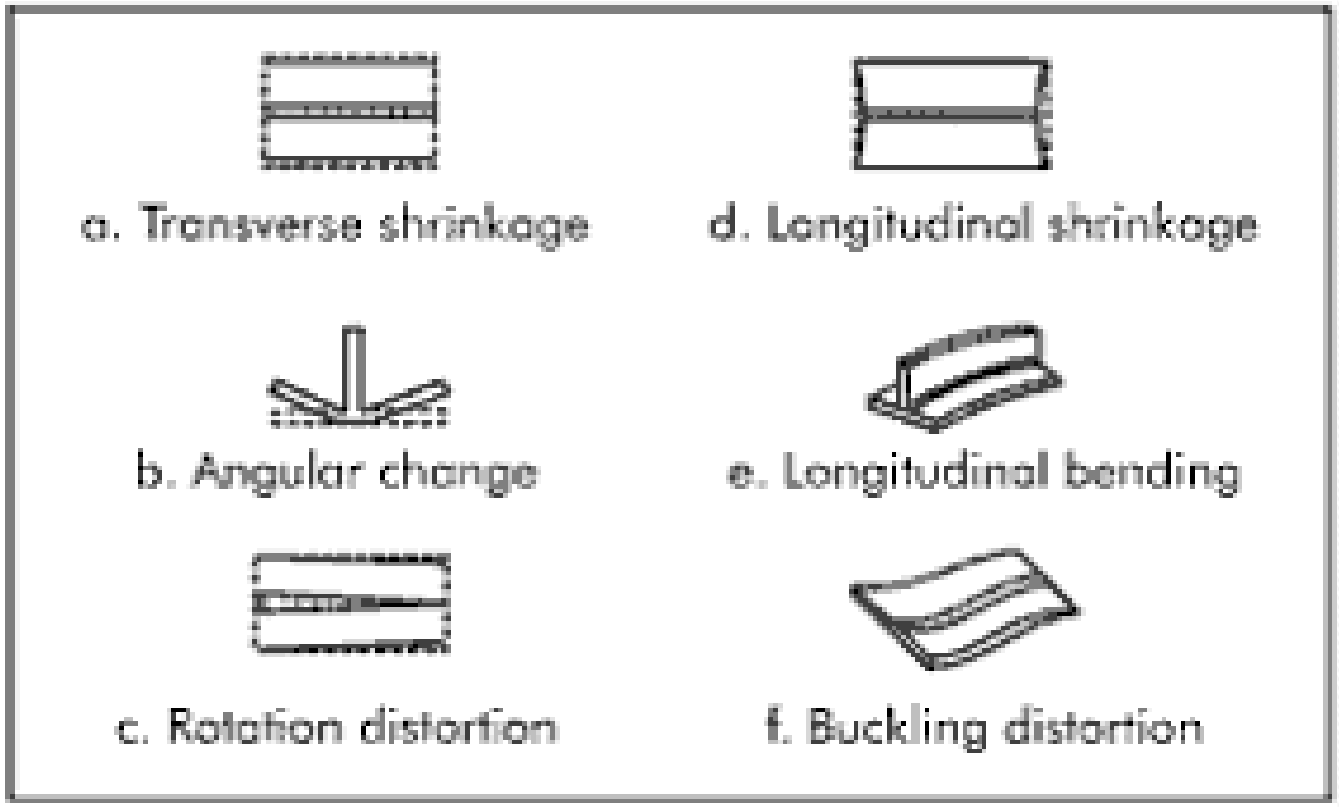


Figure 10-2. *Typical types of distortion occurring during welding.*

Distortion based on material type

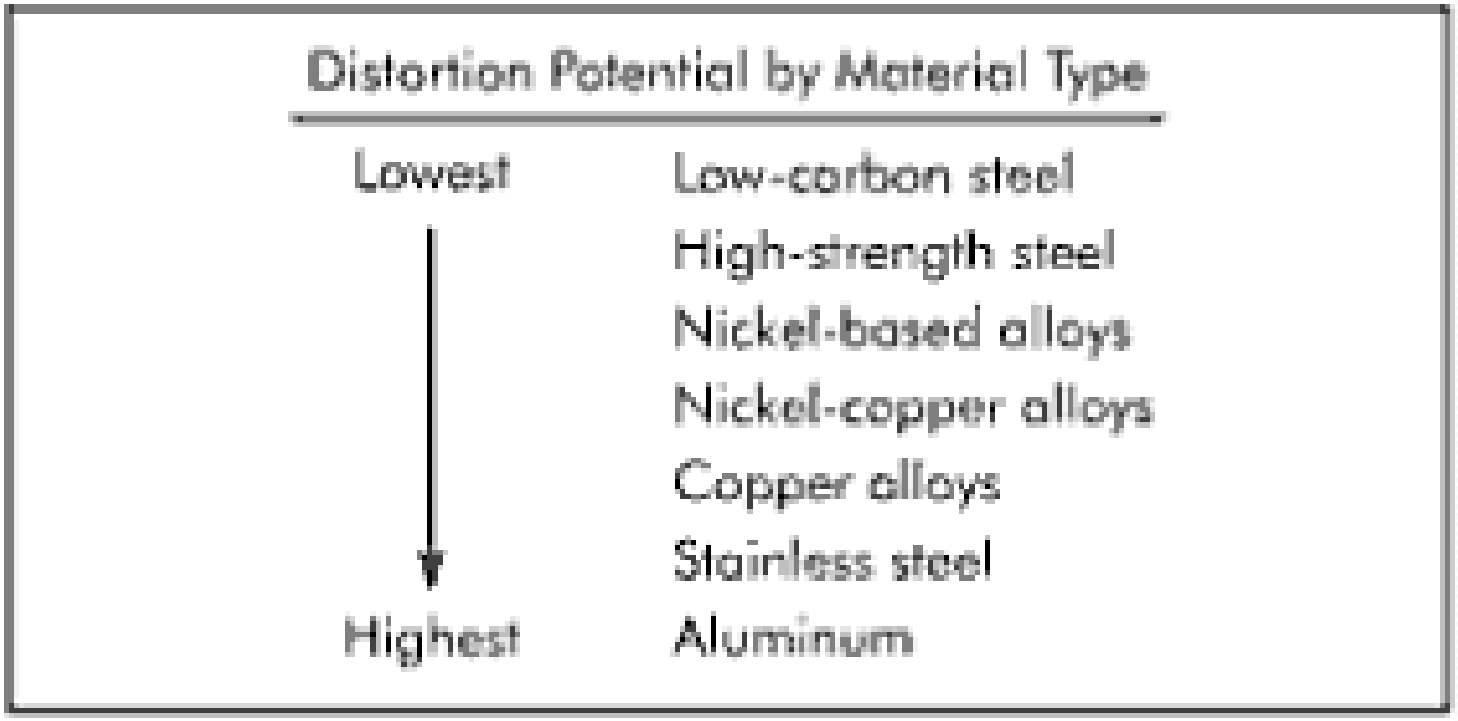


Figure 10-3. *Distortion potential based on material type.*

Fixture design objectives

- Hold the part in the best position
- Providing proper heat control of the weld zone
- Provide suitable clamping to reduce distortion
- Providing channels and outlets for welding atmosphere
- Providing access for the welding process
- Providing for ease of operation, part loading and unloading

Other factors

- Cost of fixture
- Size of the production run and rates
- Adaptability of available welding equipment
- Complexity of the weld
- Quality required in the weldment
- Welding process to be used
- Conditions of welding
- Dimensional tolerances
- Materials to be welded
- Part-surface finish requirements
- Coefficient of thermal expansion and thermal conductivity of workpiece and tool

Gravity type fixture gas welding fixture

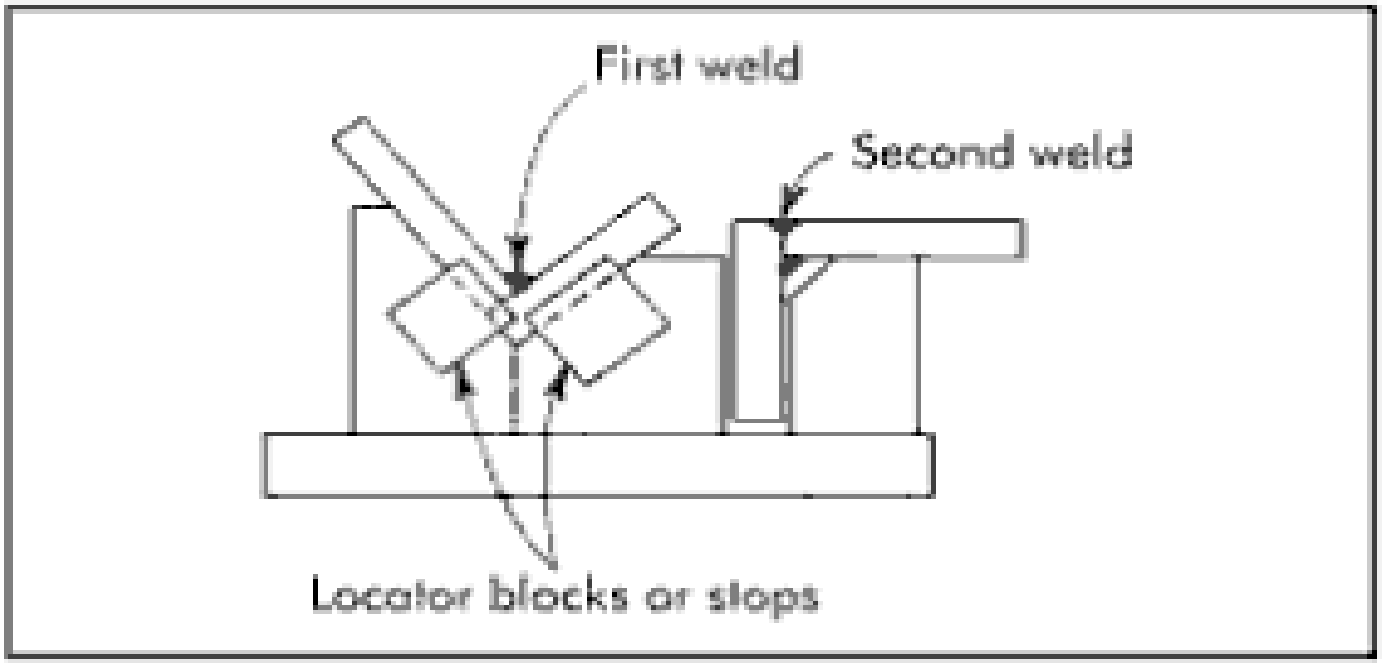


Figure 10-4. *Simple welding fixture using gravity to help locate parts.*

Gas welding fixture

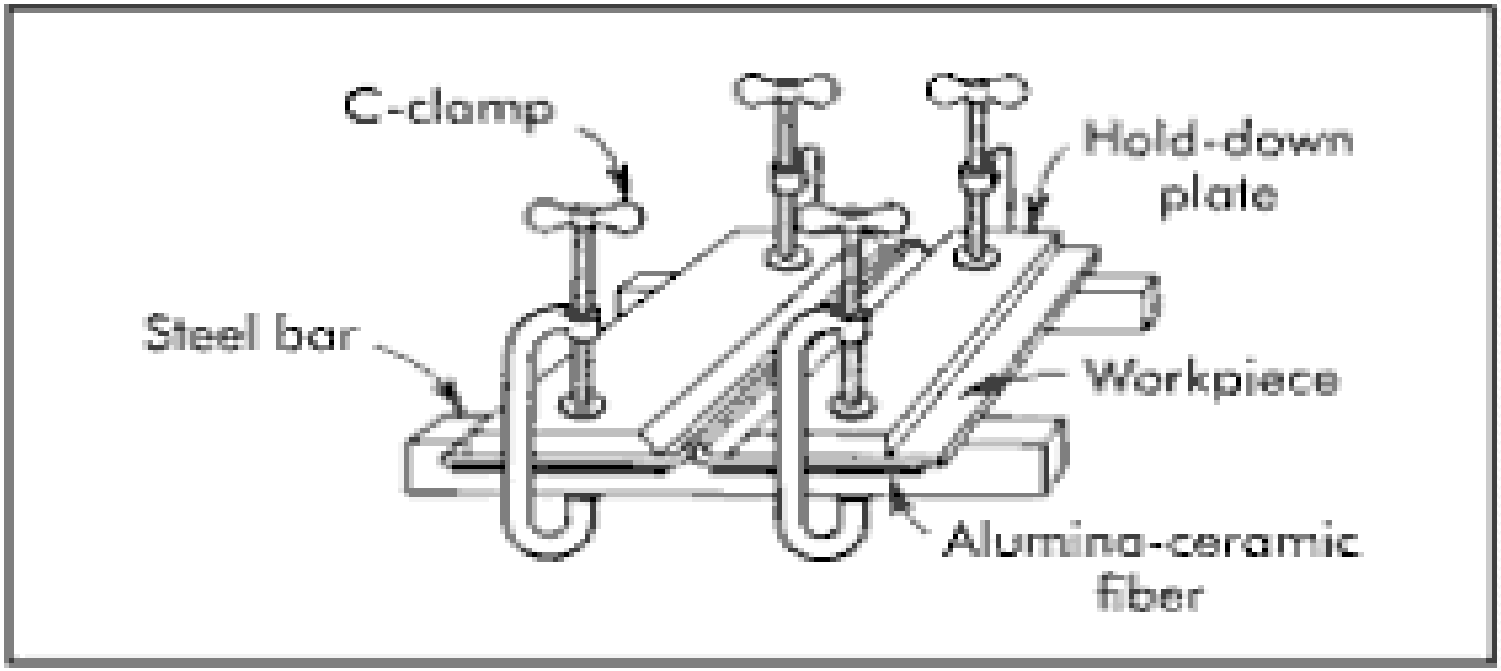


Figure 10-5. *Workpieces with simple fixturing for gas-welding operations.*

Factors for gas welding fixtures

- Part print tolerances
- Material heat resistance
- Heat-transfer qualities
- Fixture rigidity required to ensure workpiece alignment accuracy
- Prevent rapid heat dissipation from the weld area
- Cast Iron, carbon steel and stainless steel

Arc welding fixtures

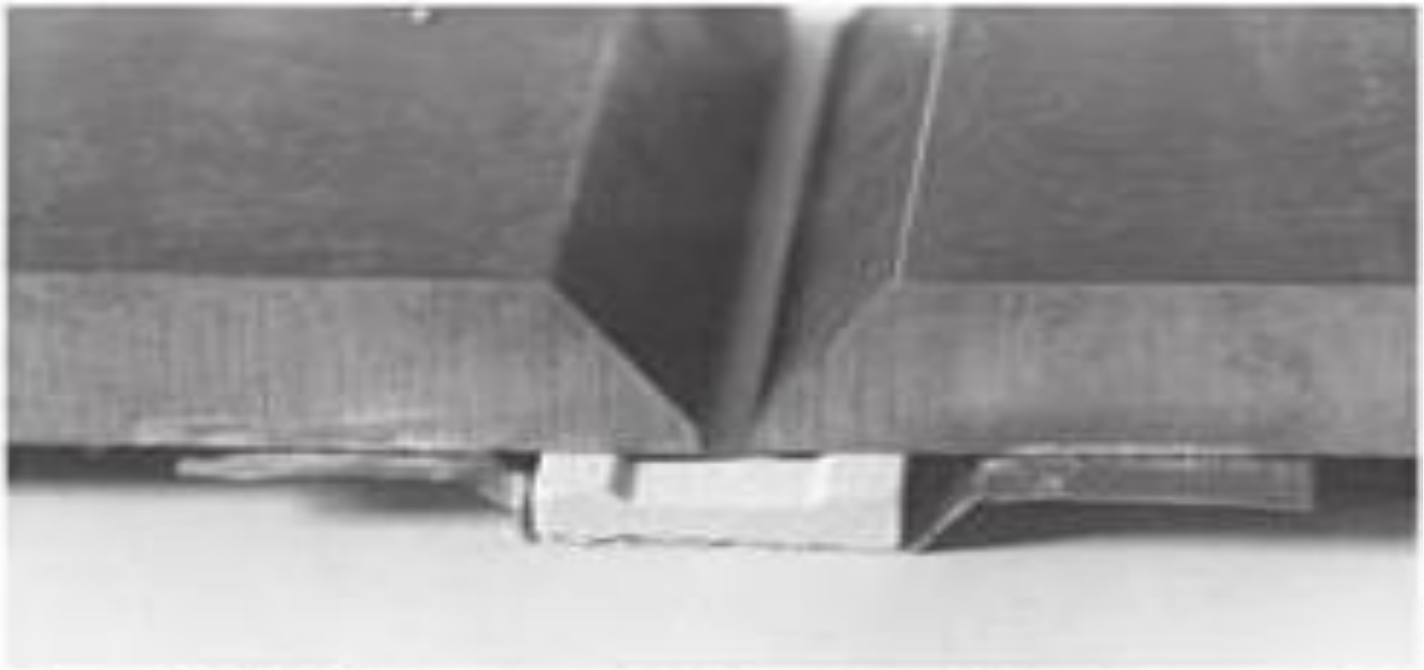


Figure 10-7. Workpiece with simple fixturing for arc-welding operations. (Courtesy Alloy Rods Division, Chemetron Corp.)

Arc welding fixtures

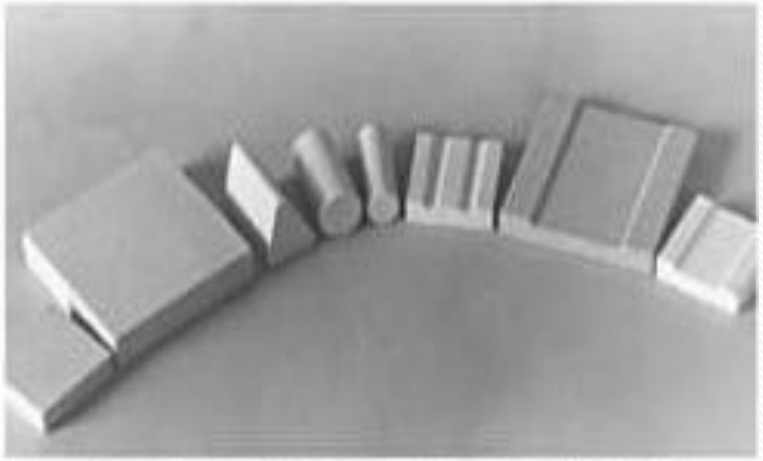


Figure 10-6. *Typical backing bars.* (Courtesy Alloy Rods Division, Chemetron Corp.)

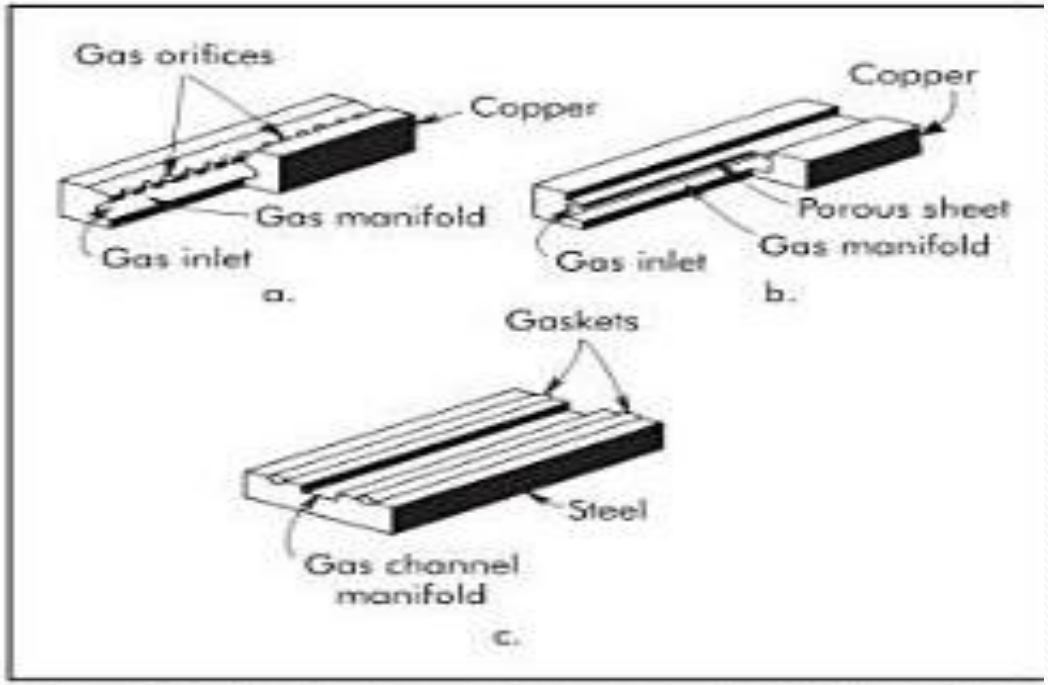


Figure 10-8. *Backing bars with provisions for (a) directed gas flow, (b) diffused gas flow, and (c) pressurized gas.*

Design considerations in arc welding

- Exert enough force to prevent or minimize part misalignment
- Too much restraint leads to weld cracking due to residual stresses
- Promote heat dissipation from the weld line
- Support the molten weld, govern the weld contour
- Protect the root of the weld from the atmosphere

Resistance Welding

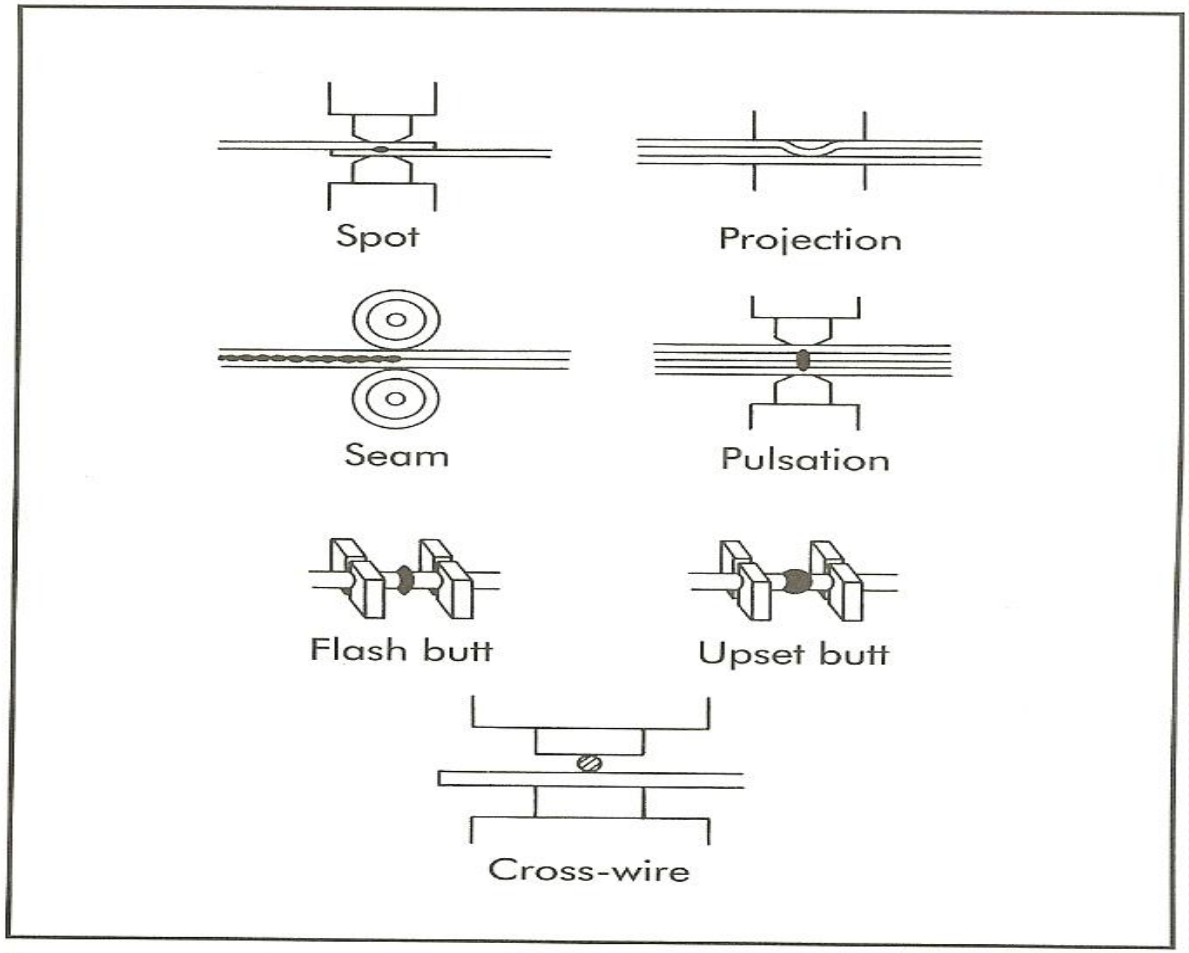


Figure 10-10. *Resistance-welding methods.*

Spot welding

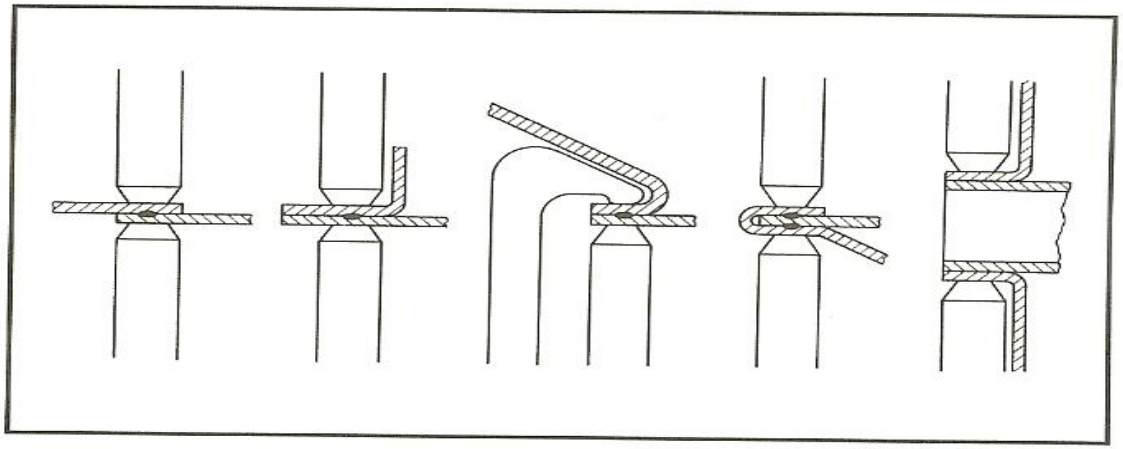


Figure 10-11. *Typical spot-welded joints.*

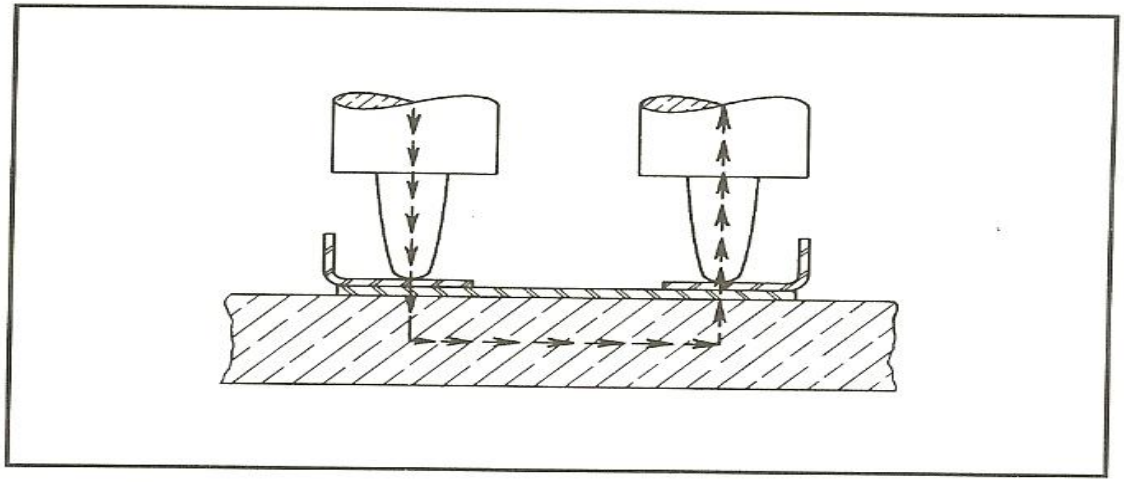


Figure 10-12. *Assembly showing series-welded joint.*

Spot weld assembly

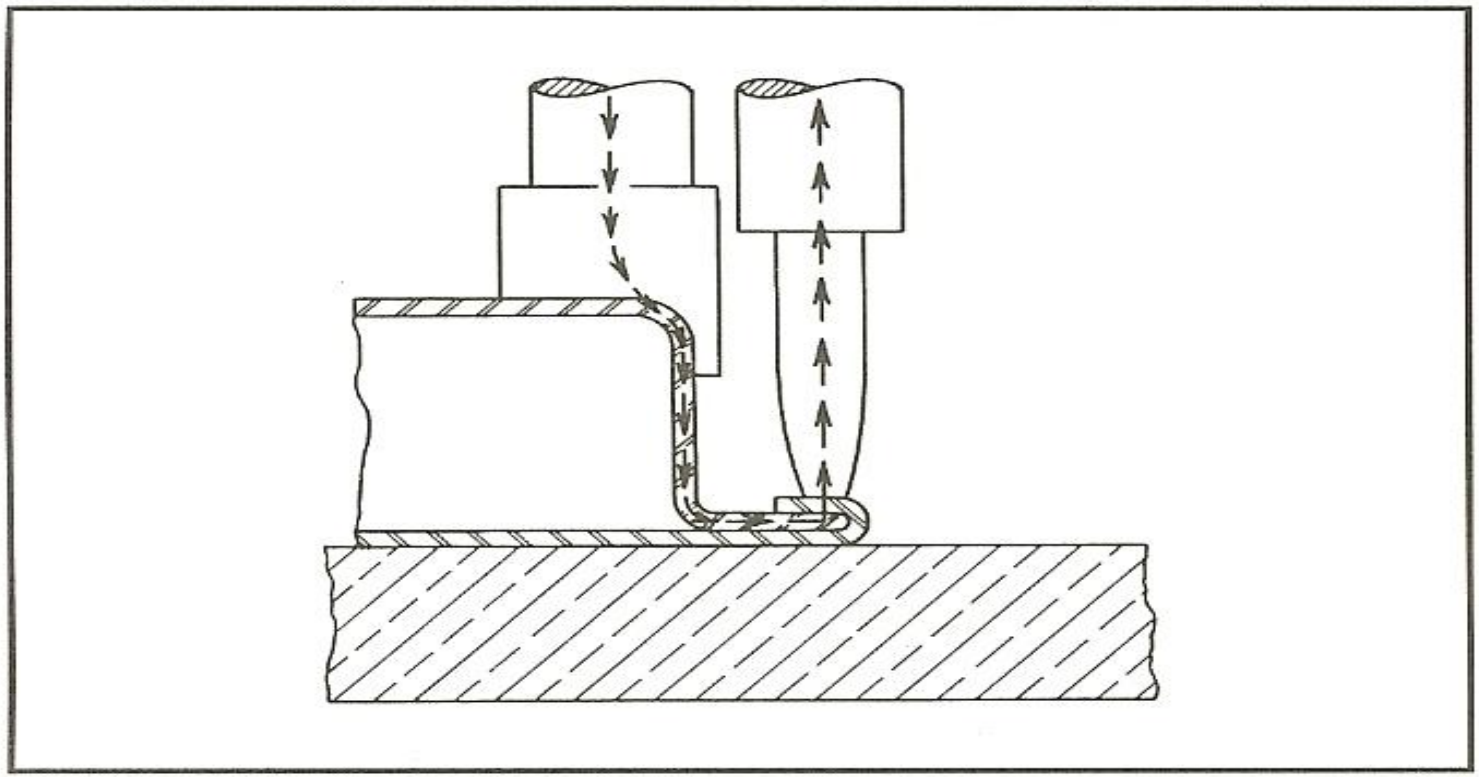


Figure 10-13. *Spot-welded assembly showing a typical joint design for an indirect weld.*

Flash butt welding

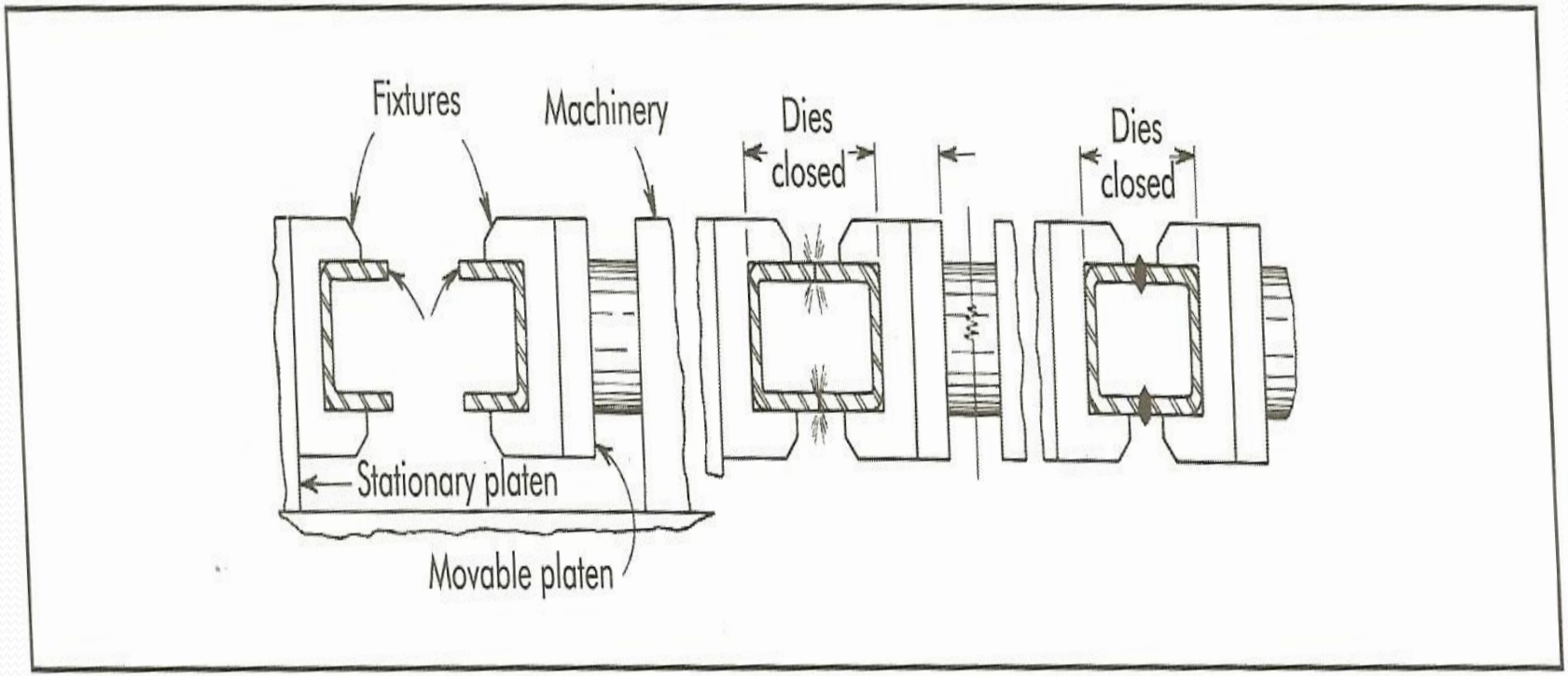


Figure 10-14. *Flash-butt welding.*

Typical standard electrodes

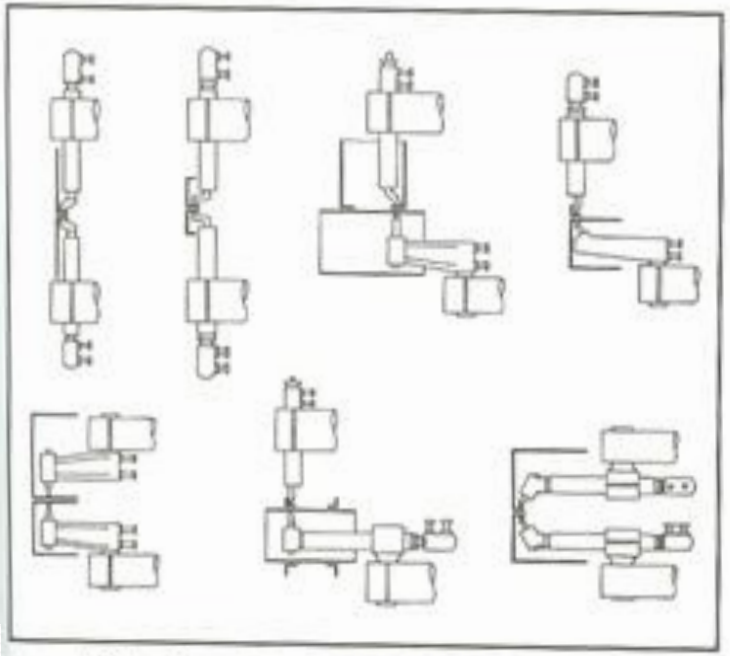


Figure 10-15. *Typical standard electrode tips and operations.*

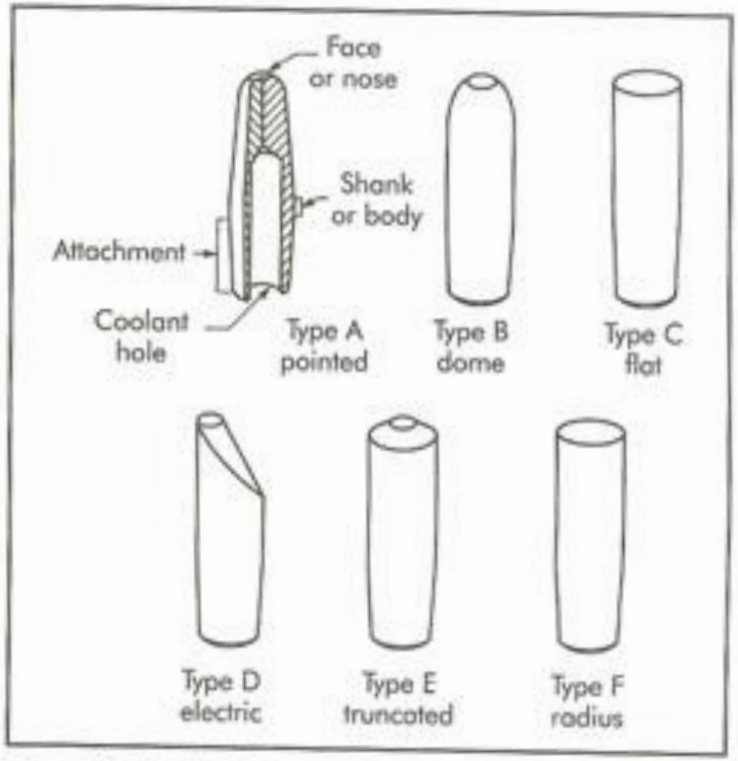


Figure 10-16. *Standard types of electrode face or nose shapes. (Type D was formerly called offset.)*

Design considerations

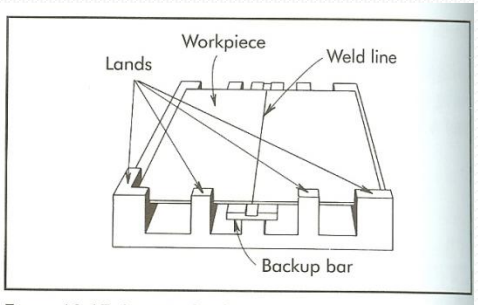


Figure 10-17. *Locating lands.*

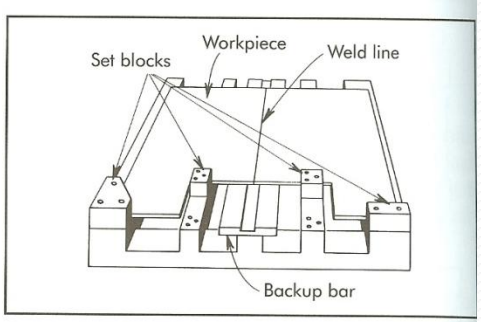


Figure 10-18. *Set-block locators.*

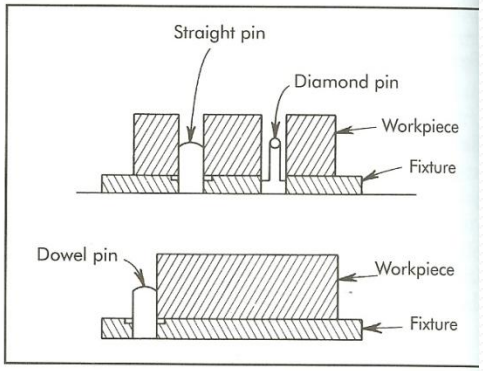


Figure 10-19. *Dowel-pin locators.*

Clamp installation

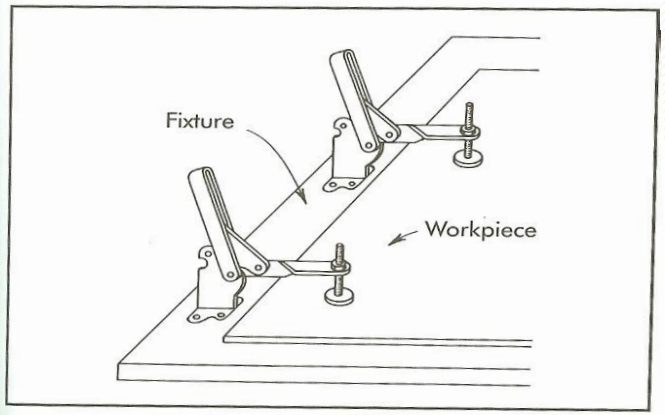
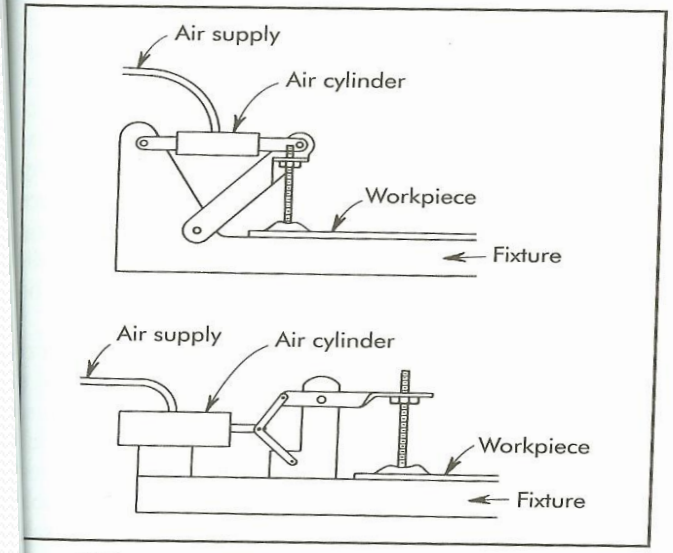


Figure 10-20. *Typical clamp installation with the fixture supporting the workpiece directly beneath the clamps.*



igure 10-21. *Air-actuated clamping methods.*

Laser welding

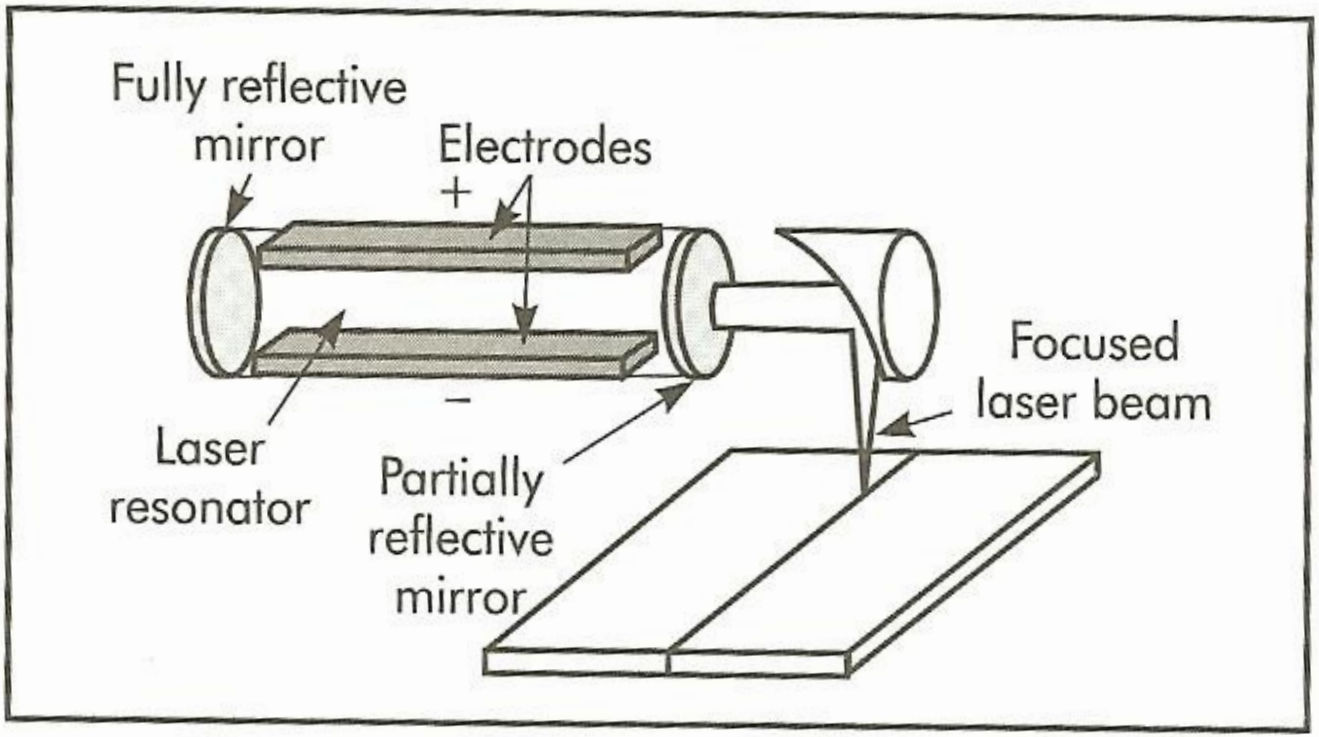


Figure 10-22. *Laser welding.*

Nesting fixture

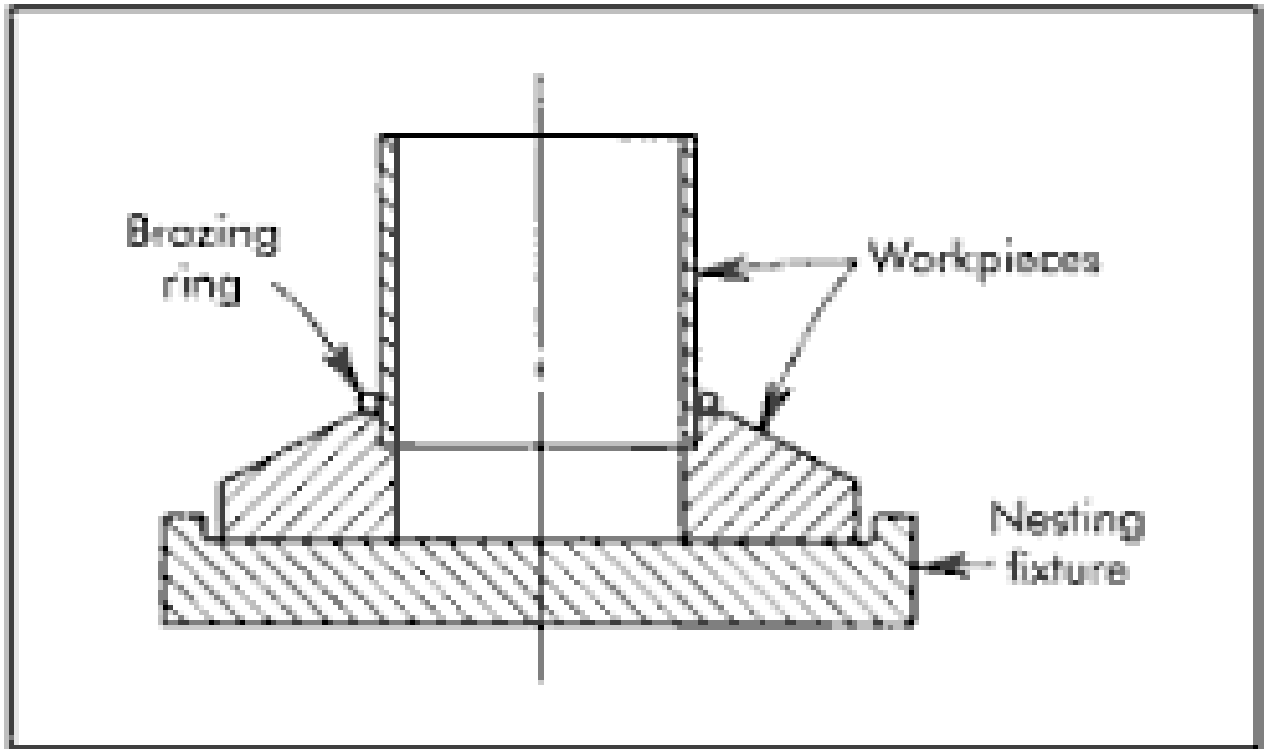


Figure 10-23. Simple nesting fixture with work in place.

Soldering machine with nesting fixture

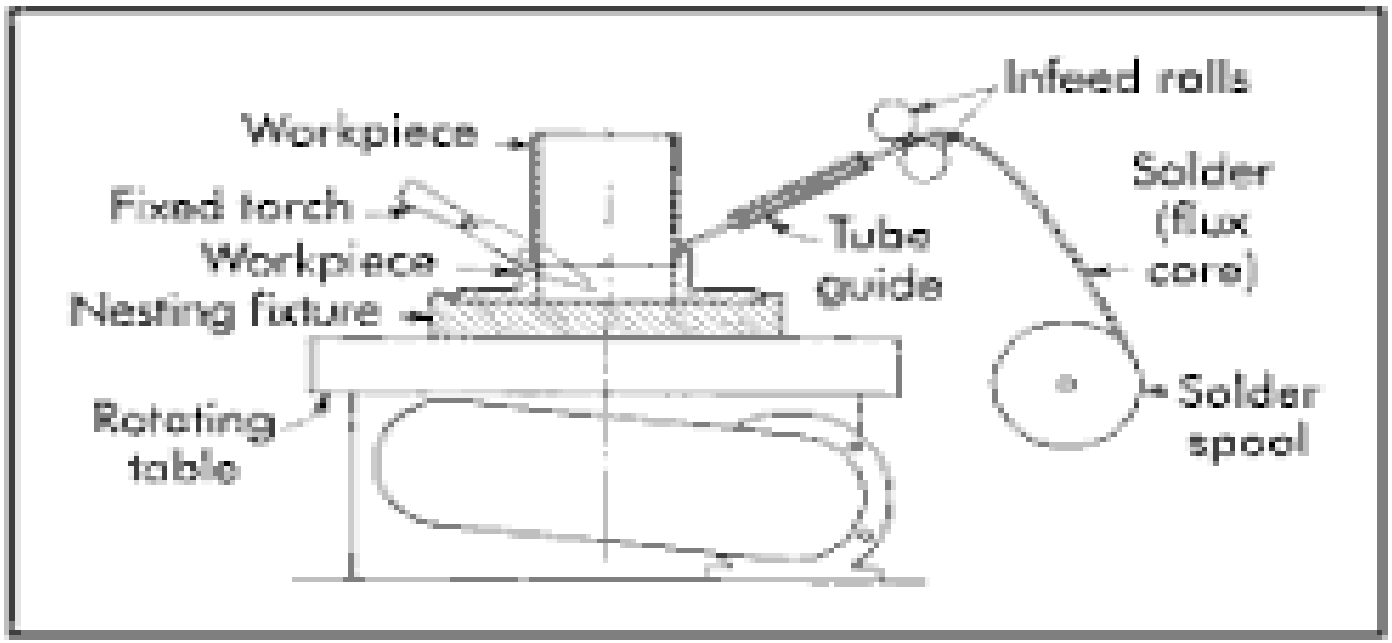


Figure 10-24. Soldering machine using simple nesting fixture.

Nesting for brazing

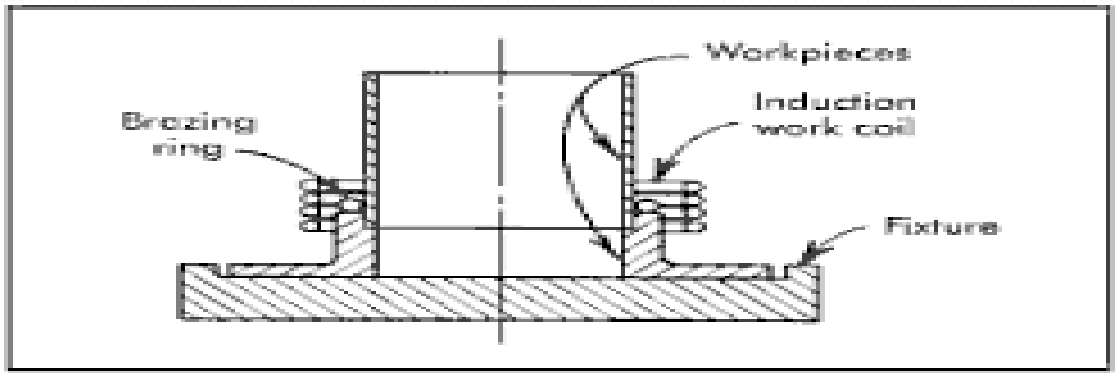


Figure 10-25. *Nesting fixture for brazing with an external inductor.*

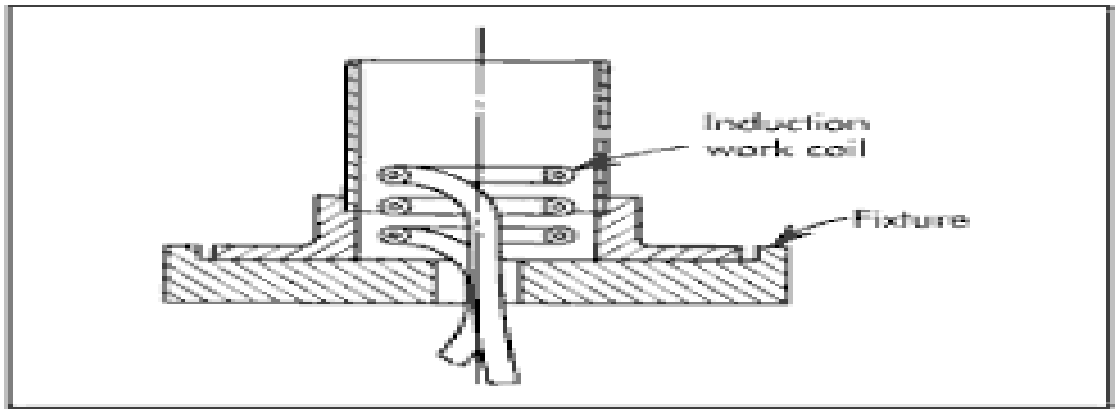


Figure 10-26. *Nesting fixture for brazing with an internal inductor.*

Bolts and studs

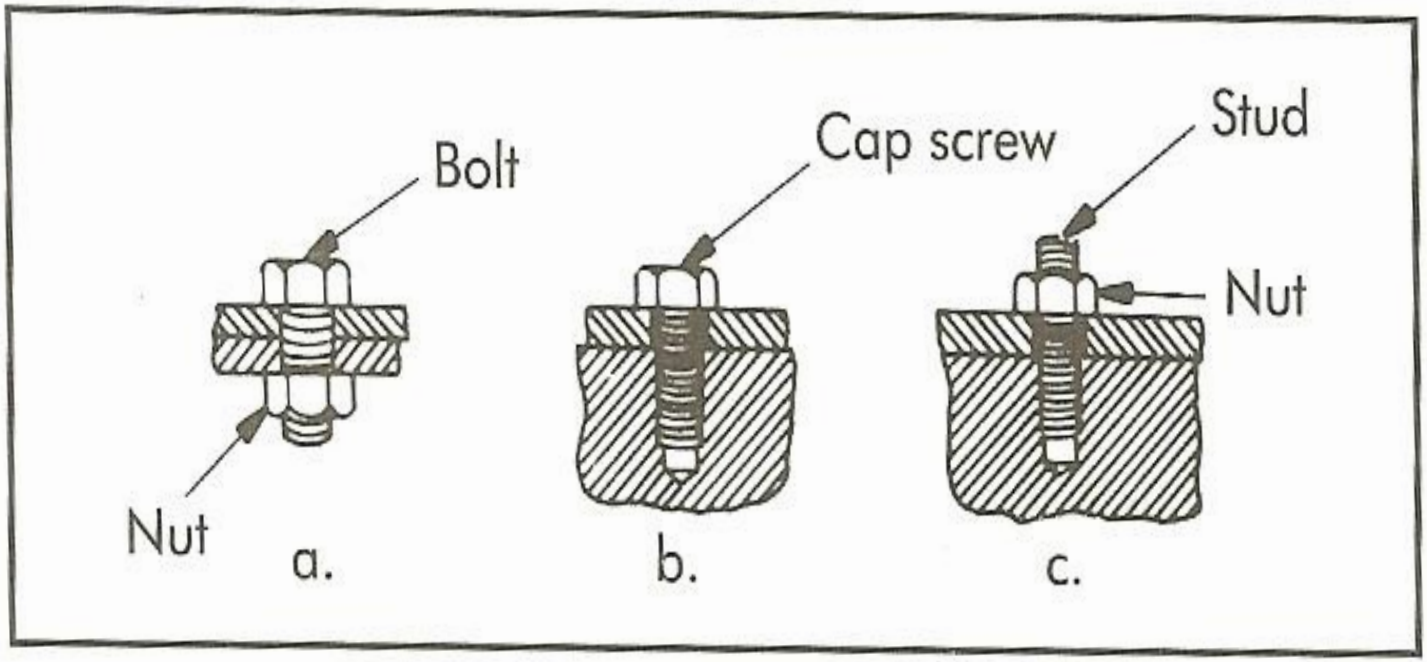


Figure 10-33. *Typical assemblies using threaded fasteners:* (a) *bolt and nut;* (b) *cap screw;* (c) *stud.*

Single-thread nut

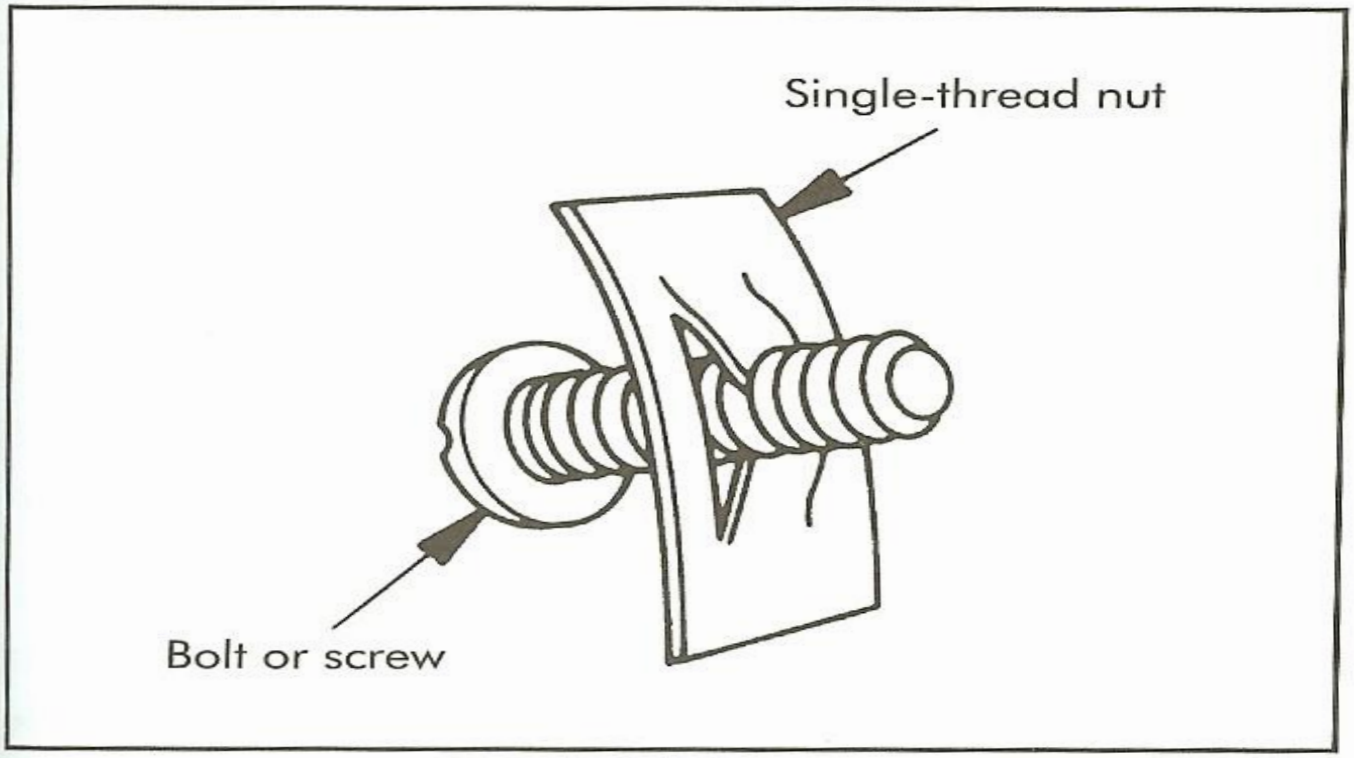


Figure 10-34. *Single-thread nut.*

Stamped nut

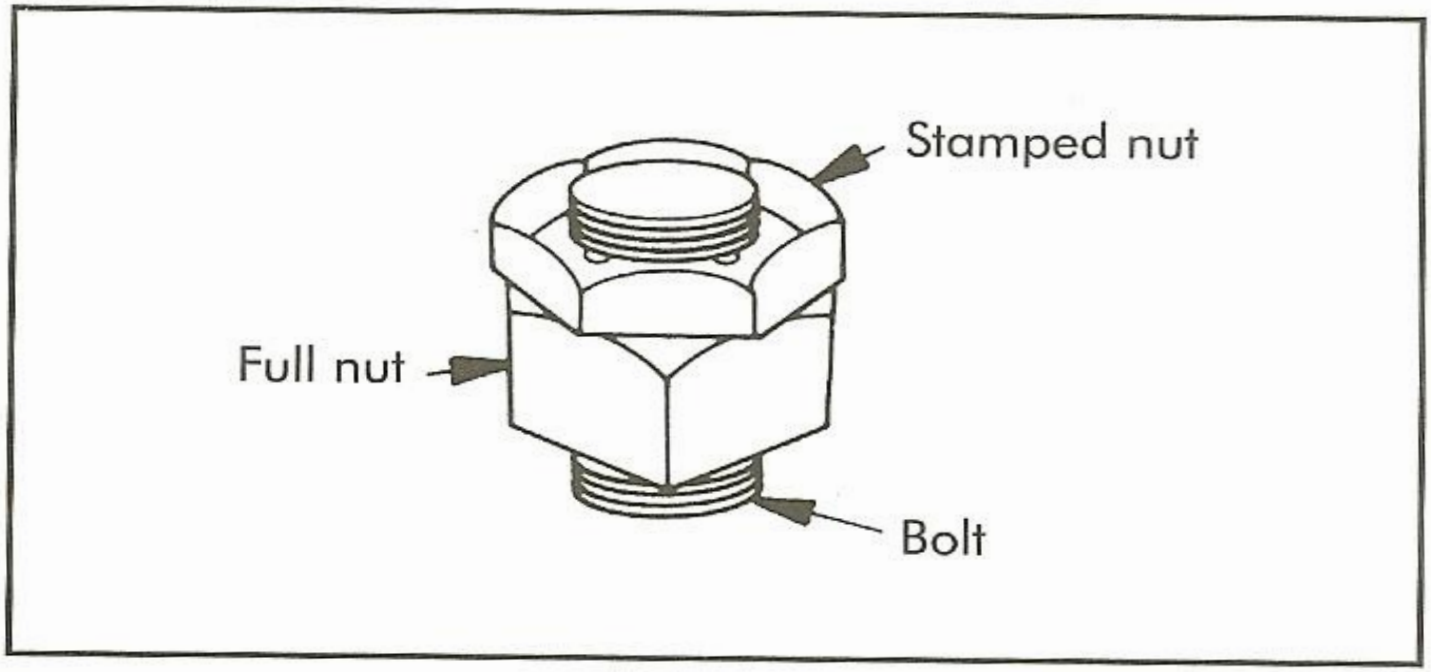


Figure 10-35. *Stamped nut applied and tightened after full nut is in place.*

Riveting

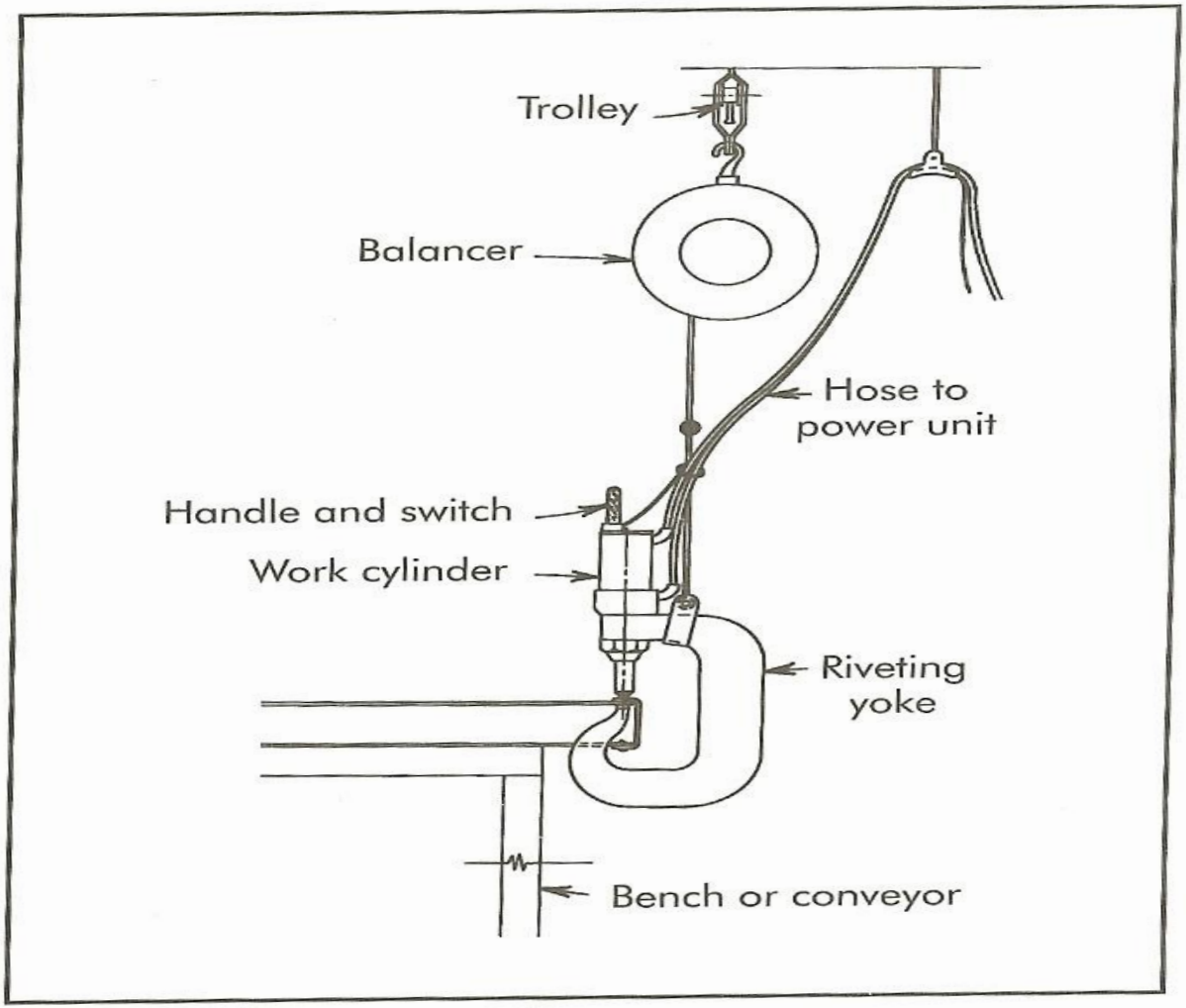


Figure 10-38. *Workpiece simply supported for riveting.*

References

- Fundamentals of tool design, fifth edition, Society of Manufacturing Engineers
- Donaldson, and Lecain, Tool Design, McGraw Hill

Questions?