

Gas Shielded Welding Processes

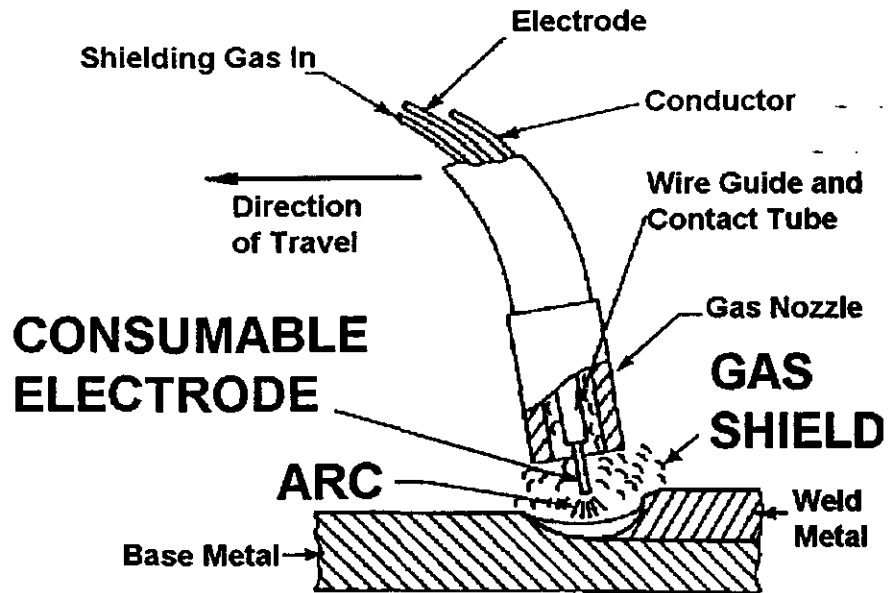
Gas Metal Arc Welding (GMAW)

Gas Metal Arc Welding

Process Fundamentals

- In GMAW the welding heat source is an arc maintained between a consumable wire electrode and the workpiece
- The weld is formed by melting and solidification of the joint edges together with filler material transferred from the electrode
- An flow of inert gas shields the high-temperature arc and weld pool from reactions with the surrounding atmosphere

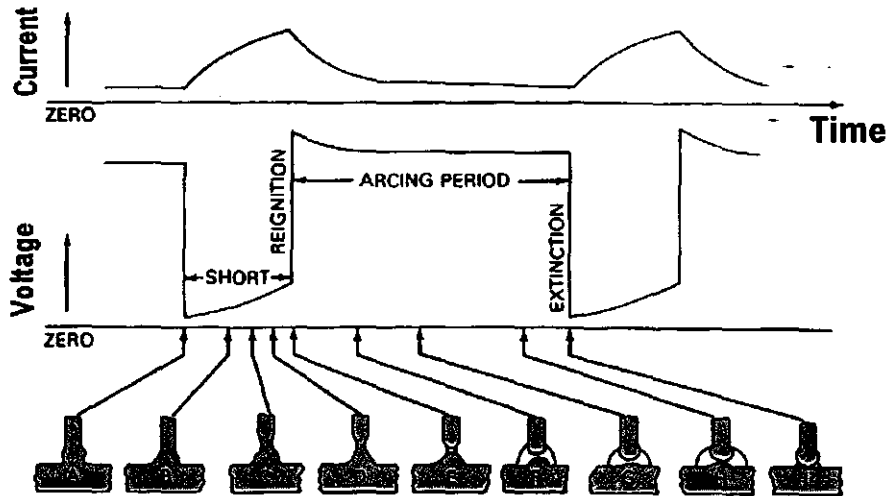
GMAW Process Fundamentals



GMAW Metal Transfer Modes

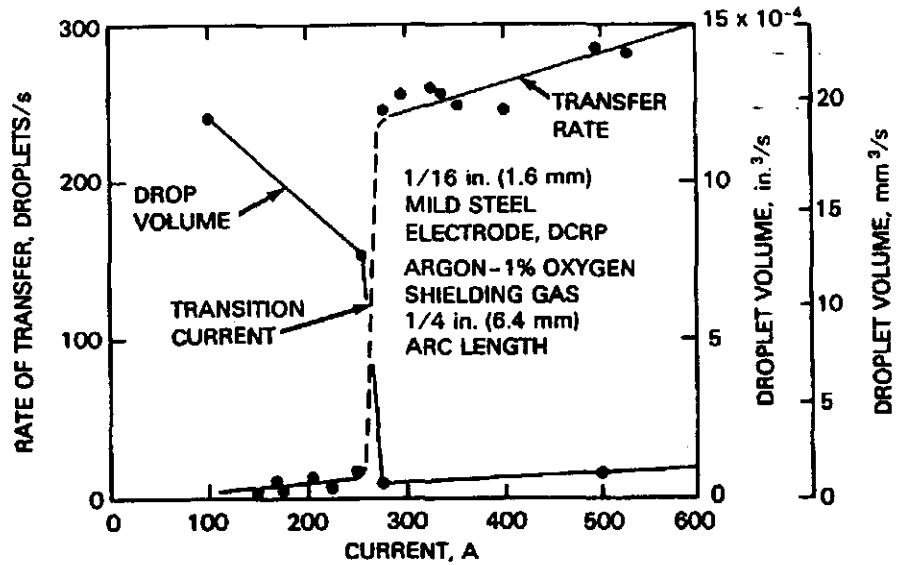
- Short Circuiting or "Dip" Transfer
- Globular Transfer
- Spray Transfer
- Pulsed or Synergic Transfer

GMAW Short Circuiting Transfer

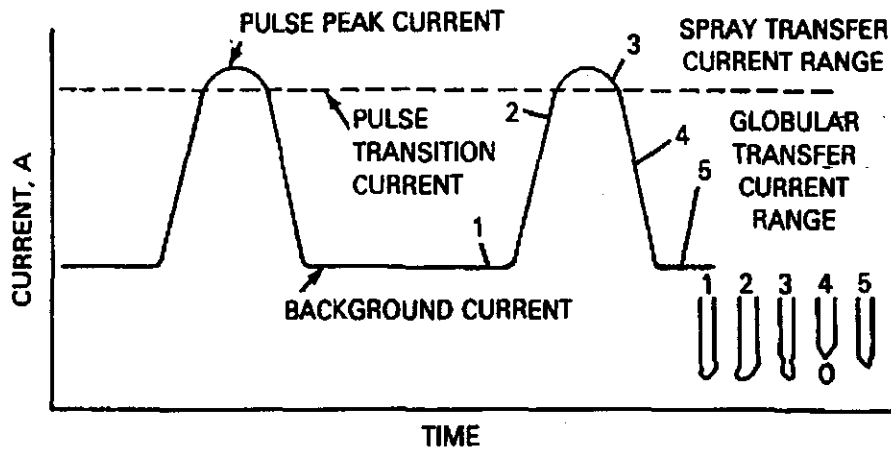


GMAW Spray Transfer

Variation in volume and rate of drop transfer with welding current

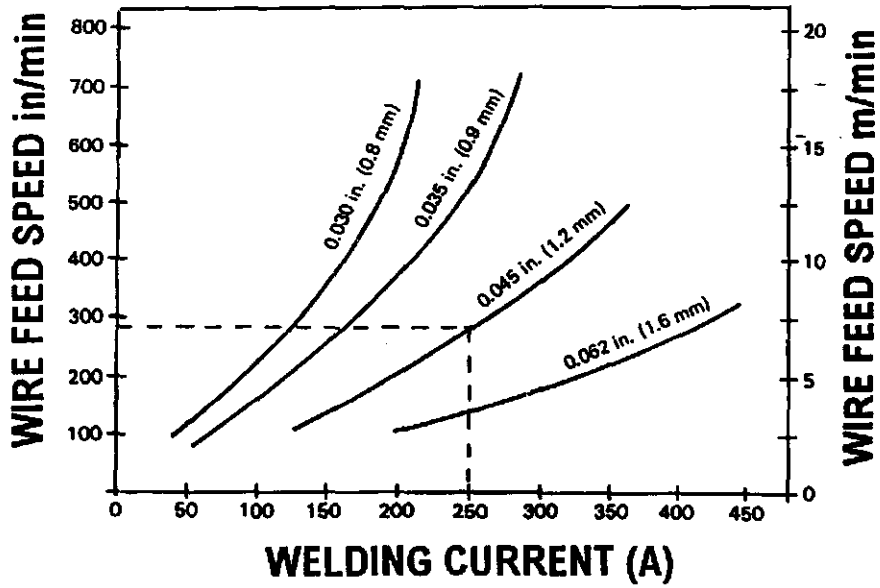


GMAW Pulsed Transfer



- Pulse frequency and amplitude determine wire melting rate
- "Synergic" control automatically gives the optimum pulse conditions for a given wire feed rate

GMAW Electrode Melting Rate

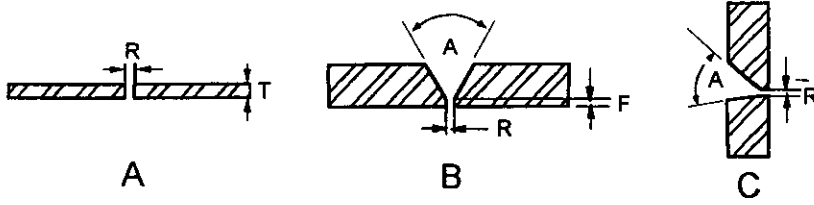


GMAW Consumables

- Electrode composition is usually similar to desired weld metal composition with additional deoxidizers e.g. Si, Al, Ti
- Electrodes are covered by AWS and other specifications
 - Carbon steel electrodes AWS A 5.18.
- Shielding Gases
 - Various shielding gases are used depending on metal being welded and desired transfer mode
 - Principally Ar, CO₂ and mixtures of Ar-CO₂, O₂ or He
 - Several commercial "brand-name" compositions

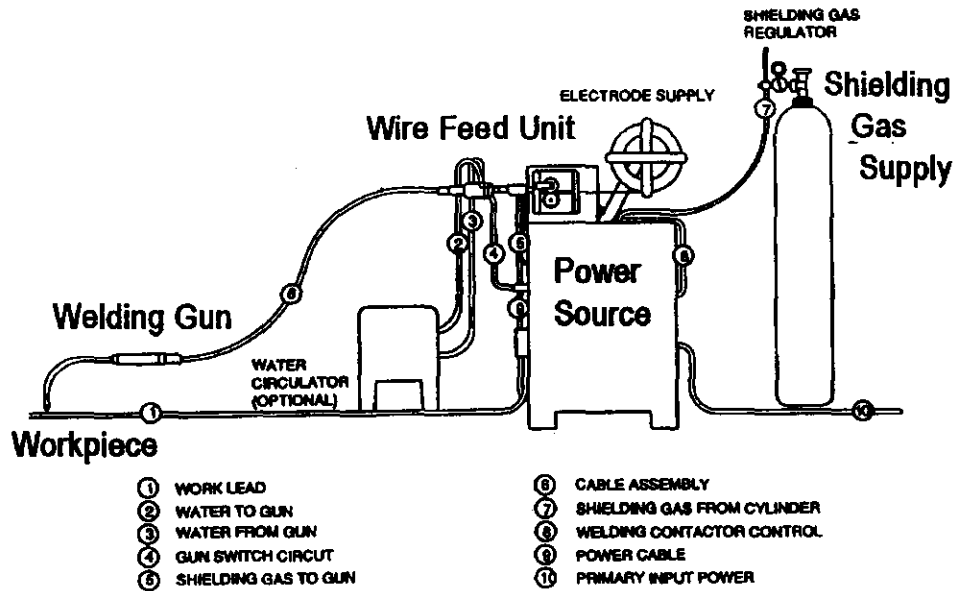
GMAW Typical Welding Procedures

Carbon Steel

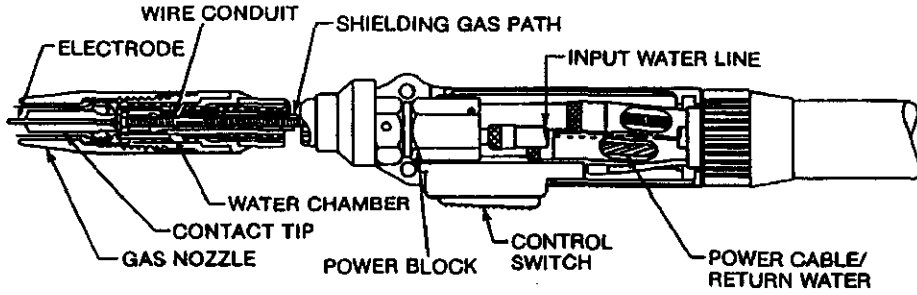


Joint	T mm	R mm	F mm	A Deg	Wire Dia mm	Current A	Voltage V	Wire Feed mm/s	Shielding Gas	Gas Flow Rate l/min
A	1.5	0	-	-	0.9	95	18	64	75%Ar 25%CO ₂	12
B	5-25	1.5-4	3	60	1.1	250	26	100	95%Ar 5%CO ₂	12
C	5-25	1.5-4	3	60	1.1	250	26	100	95%Ar 5%CO ₂	12

GMAW Welding Equipment

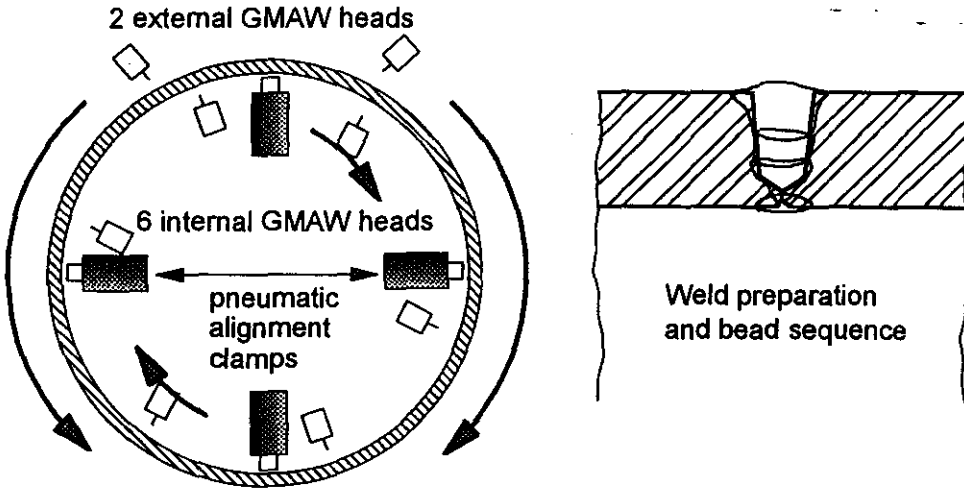


GMAW Welding Gun



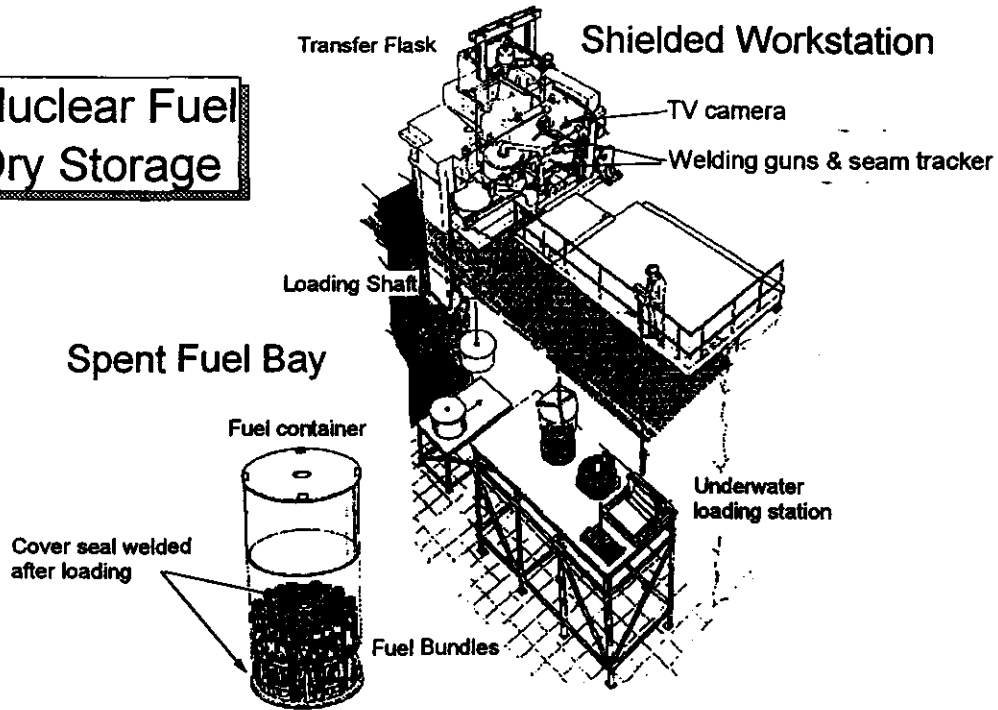
GMAW Mechanized Application

Field welds in oil/gas transmission pipelines

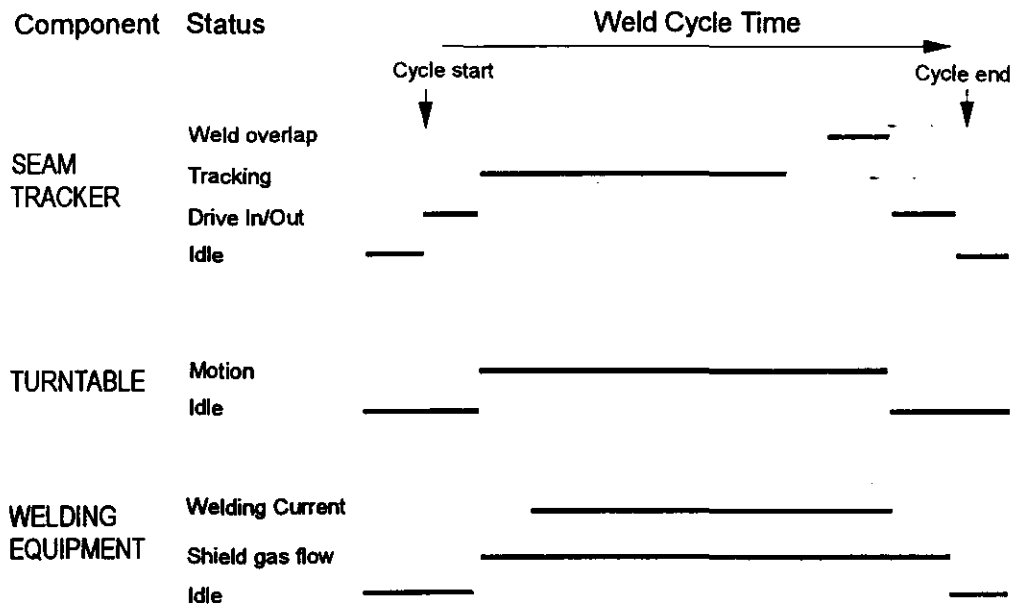


GMAW: Mechanized Applications

**Nuclear Fuel
Dry Storage**



Process Control



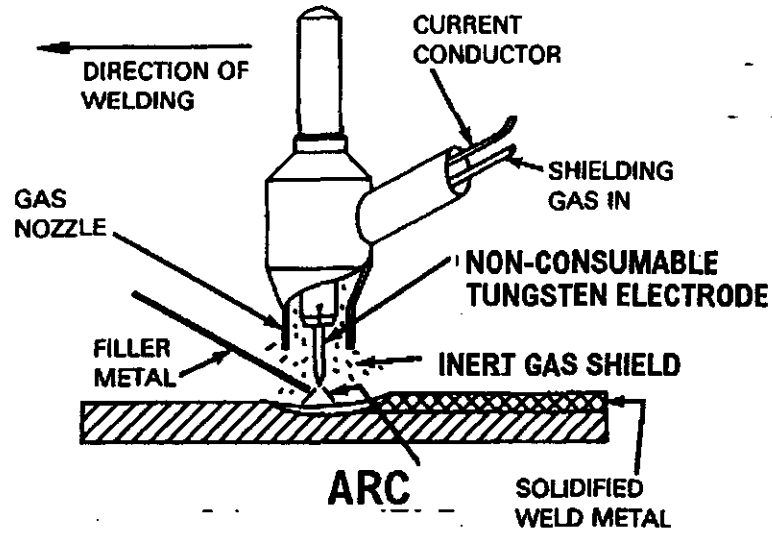
GMAW Capabilities & Limitations

- | | |
|---|--|
| <ul style="list-style-type: none">+ Applicable to range of metals and thicknesses+ Higher production rates than SMAW or GTAW+ No flux or slag residues+ Adaptable to manual or mechanized/robotic applications | <ul style="list-style-type: none">- Complex equipment and set up<ul style="list-style-type: none">▸ Wire feeding can be temperamental- Less portable than SMAW- Gas shield sensitive to air currents |
|---|--|

WELDING PROCESSES

GAS TUNGSTEN ARC WELDING (GTAW)

GTAW: Process Fundamentals



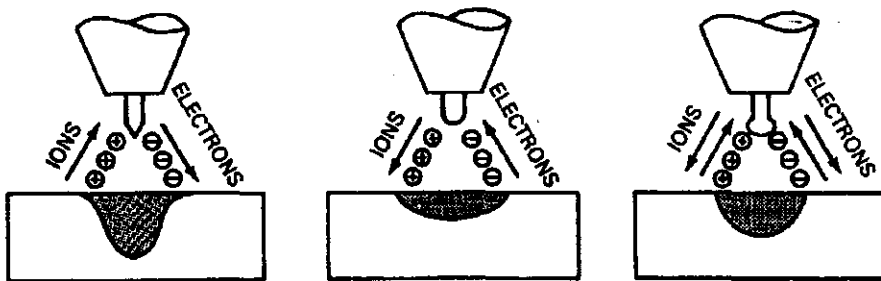
GTAW: Process Variables

- **Welding current**
 - DC, pulsed DC, high frequency pulsation, AC, variable polarity AC
- **Arc length (Voltage)**
- **Weld travel speed**
- **Oscillation**
- **Filler addition**
- **Shielding gas composition & flow rate**
 - generally Ar or He or mixtures.

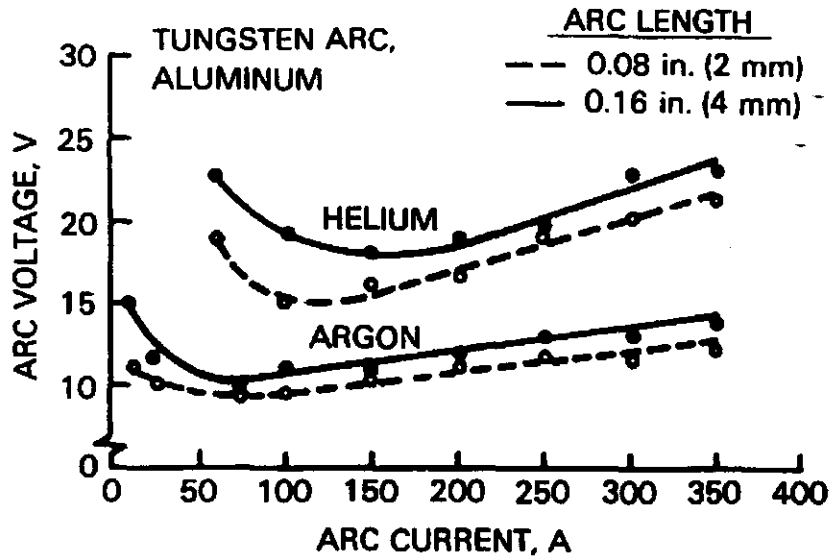
GTAW: Current Polarity

- DCEP is mostly used
 - approx 70% of heat produced at anode (workpiece)
- DCEN used to disperse tenacious surface oxides when welding Al, Mg
- AC also used in Al welding
 - variable polarity pulsed AC

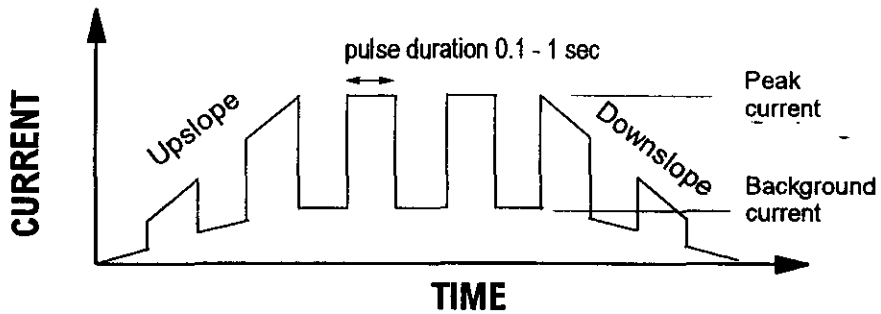
GTAW: Effect of Polarity



GTAW: Arc Voltage



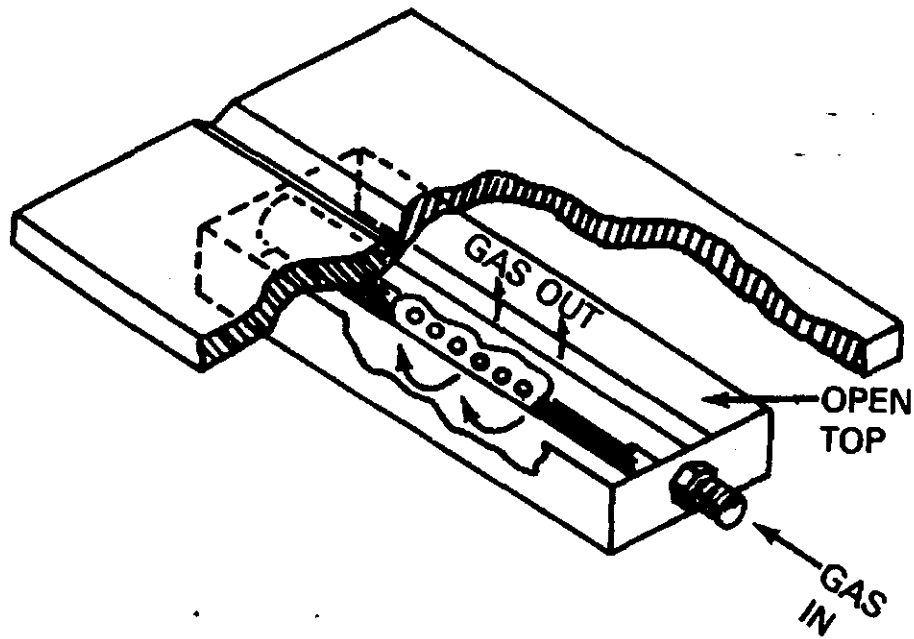
Pulsed GTAW (PGTAW)



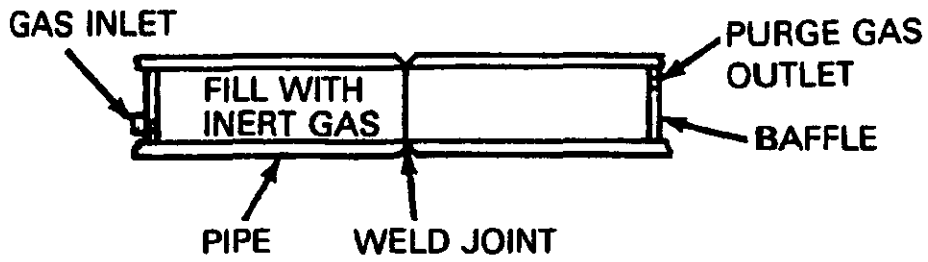
Pulsed DC advantages:

- ✓ Greater penetration for given average current
- ✓ Minimizes heat affected zone & distortion
- ✓ Improved capability to weld in all positions

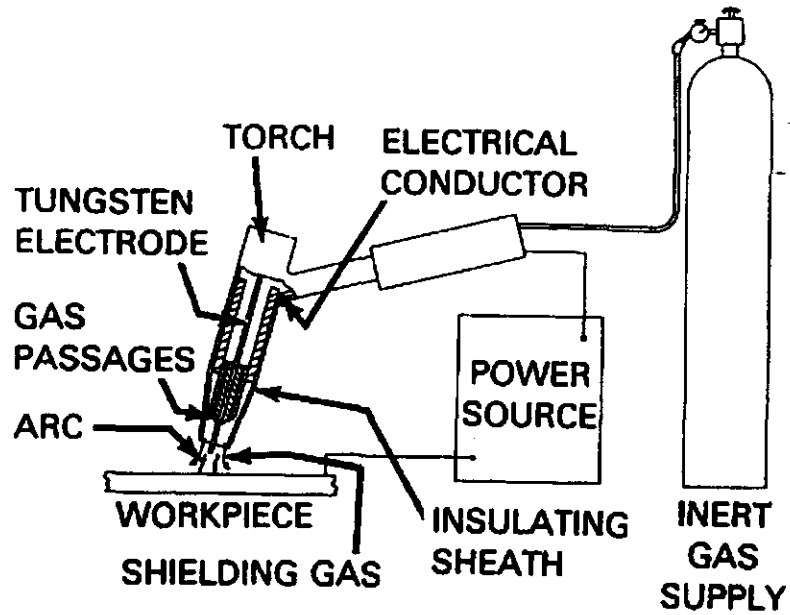
GTAW: Gas backing



GTAW: Pipe internal purge



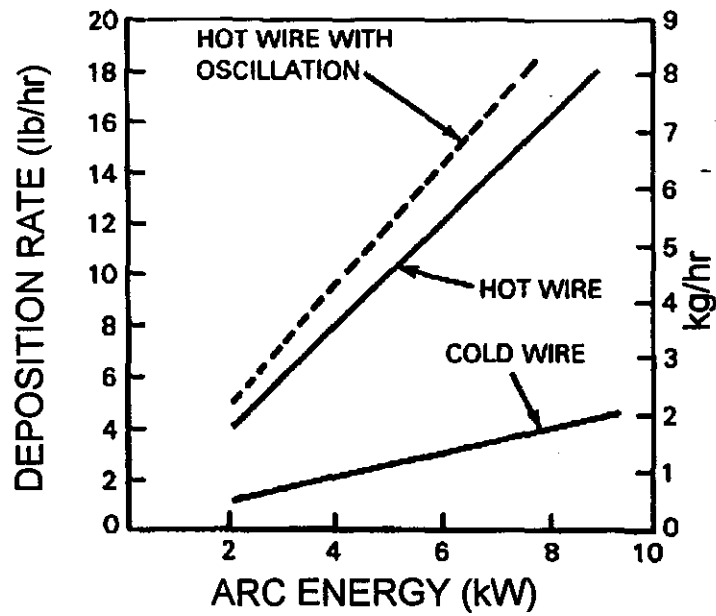
GTAW Equipment Schematic



Mechanized GTAW Applications

- **Mechanization of**
 - weld head travel motions
 - wire feed (if required)
 - process controls: start/stop sequence, weld current profile, shielding gas flow, etc
- **Typical applications: Pipe, tube, tube-tubesheet welding, longitudinal welds in formed tubes.**
- **Advantages of mechanization**
 - Increased productivity
 - reduced weld defect rates
 - shorter joint completion times
 - reduced need for skilled labour

GTAW Deposition Rates



GTAW Capabilities & Limitations

- + Superior quality welds free from flux residues or spatter
 - + Excellent control of penetration
 - + Applicable to almost all metals
 - + Adaptable to manual or precision mechanized applications
- Low deposition rates
 - Higher welder skill required in manual processes
 - Gas shielding sensitive to air currents