Gas Shielded Welding Processes

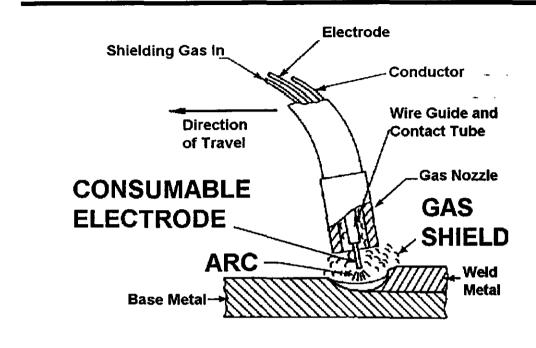
Gas Metal Arc Welding (GMAW)

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

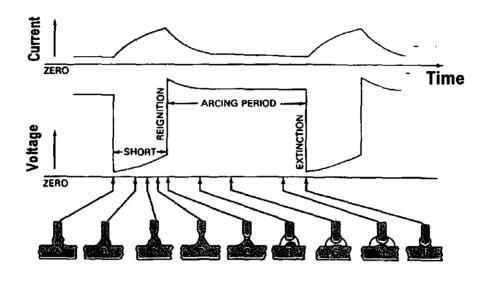
GMAW Process Fundamentals



GMAW Metal Transfer Modes

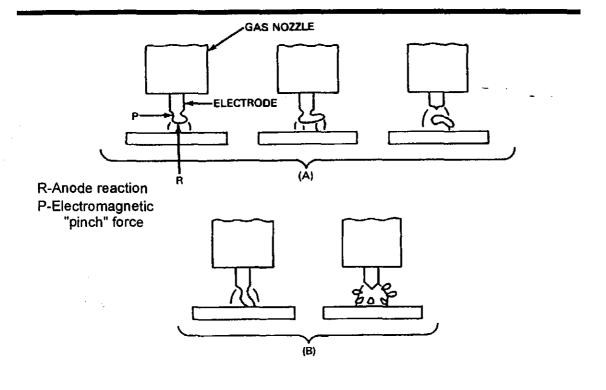
- Short Circuiting or "Dip" Transfer
- Globular Transfer
- Spray Transfer
- Pulsed or Synergic Transfer

GMAW Short Circuiting Transfer



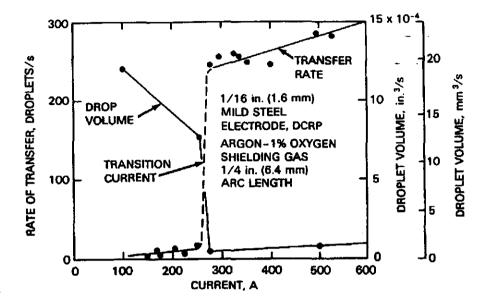
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GMAW Globular Transfer Mode

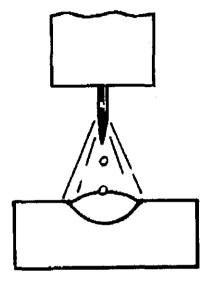


GMAW Spray Transfer

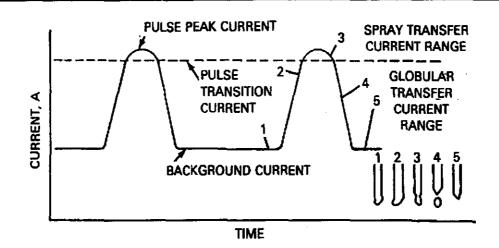
Variation in volume and rate of drop transfer with welding current



GMAW Spray Transfer



GMAW Pulsed Transfer



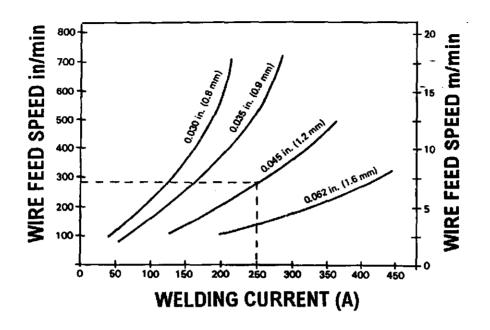
- Pulse frequency and amplitude determine wire melting rate
- "Synergic" control automatically gives the optimum pulse conditions for a given wire feed rate

GMAW Welding Procedures

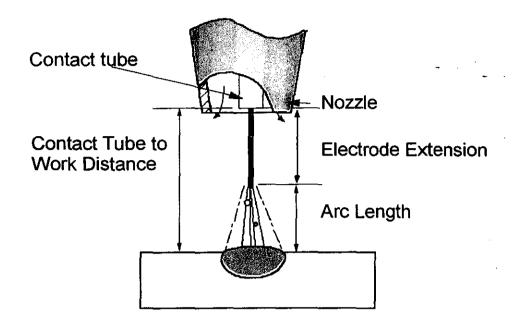
- Process Variables
 - Welding current (electrode melting rate)
 - Polarity
 - Arc voltage (length)
 - Travel speed
 - Electrode extension
 - Electrode size
 - Shielding gas composition

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GMAW Electrode Melting Rate



GMAW Torch Geometry



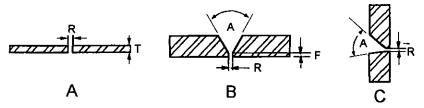
GMAW Consumables

- 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

 	 		
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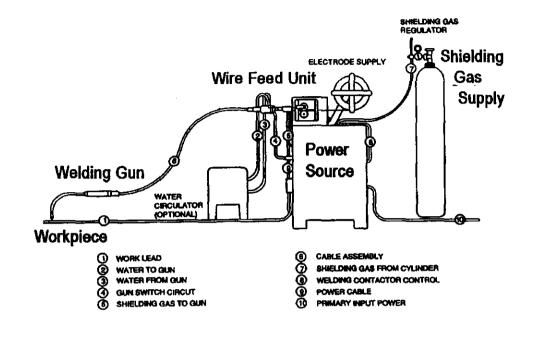
GMAW Typical Welding Procedures

Carbon Steel

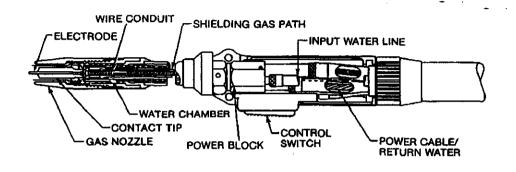


Joint T R F A	Wire Current Voltage	Wire Shielding Gas Flow
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	Dia	Feed Gas Rate
mm mm mm Deg	mm A V	mm/s t/min
A 1.5 0	9 95 18	64 75%Ar 12
		25%CQ2
0 505 454 6 50	4.4 OFA OC	AND OFFICE AD
8 5-25 1.6-4 3 60	1.1 250 26	100 95%Ar 12
		5%02
C 5-25 1.5-4 3 60	1.1 250 26	100 95%A 12
0 0723 1.044 0 00	1.1 2.30 2.0	
		-5%02

GMAW Welding Equipment



GMAW Welding Gun



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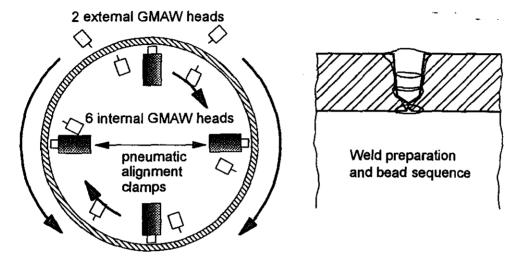
GMAW Applications

- Aluminum alloys, copper/bronze, magnesium. titanium, austenitic stainless steels, nickel alloys
- Sheet metal fabrication (short circuit mode)
 eg automotive, appliance, light structures
- General structural fabrication (spray/pulsed mode)
- High production, mechanised and robotic welding

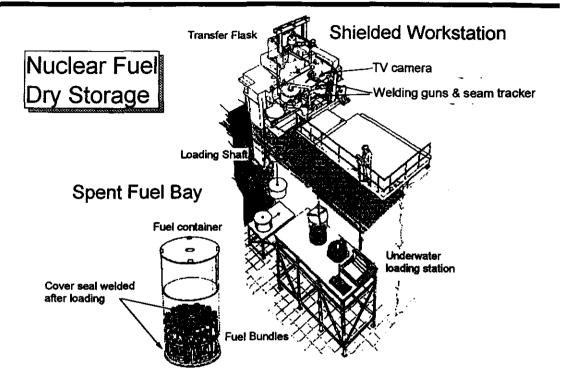
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GMAW Mechanized Application

Field welds in oil/gas transmission pipelines

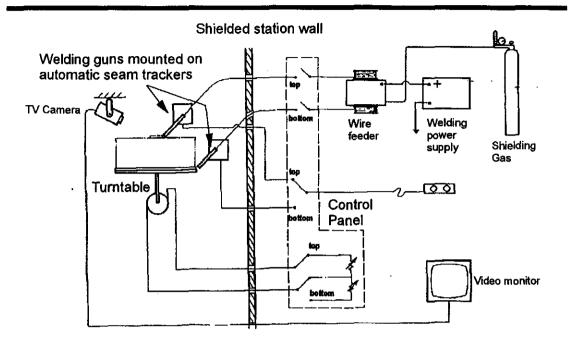


GMAW: Mechanized Applications



		 				
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GMAW: Mechanized applications



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Process Control Component Status Weld Cycle Time Cycle start Cycle end Weld overlap SEAM Tracking TRACKER Drive In/Out ldle Motion **TURNTABLE** Idle Welding Current WELDING **EQUIPMENT** Shield gas flow ldle

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GMAW Capabilities & Limitations

- 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

- Complex equipment and set up
 - Wire feeding can be temperamental
- Less portable than SMAW
- Gas shield sensitive to air currents

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WELDING PROCESSES

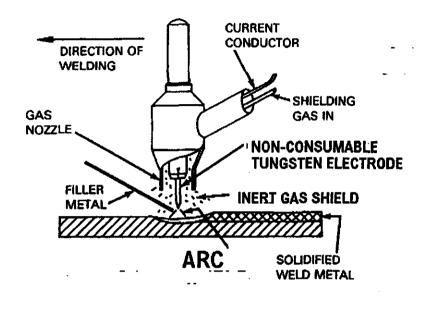
GAS TUNGSTEN ARC WELDING (GTAW)

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GTAW: Process Fundamentals

- In GTAW the welding heat source is an arc maintained between a non-consumable_ tungsten electrode and the workpiece
- Inert gas shields the arc and weld zone from atmospheric contamination
- Filler need not always be added (autogenous welding)
- Filler if required is added to the weld pool in the form of wire or rod.

GTAW: Process Fundamentals



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GTAW: Process Variables

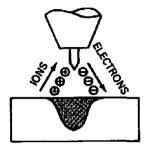
- Welding current
 - DC, pulsed DC, high frequency pulsation, AC, variable polarity AC
- Arc length (Voltage)
- Weld travel speed
- Oscillation
- Filler addition
- Shielding gas composition & flow rate
 - generally Ar or He or mixtures.

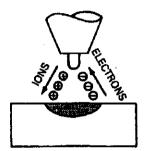
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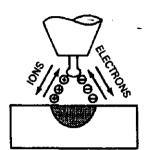
GTAW: Current Polarity

- 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

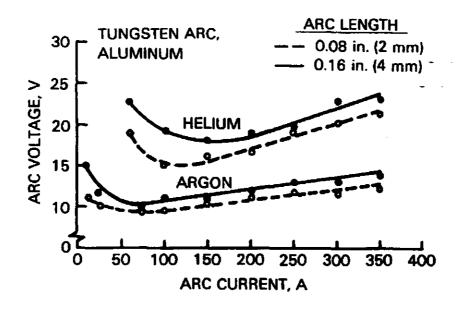




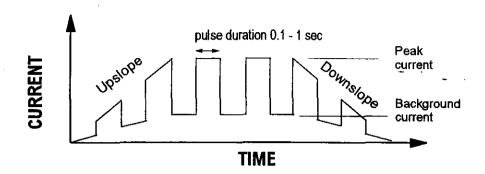


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Pulsed GTAW (PGTAW)



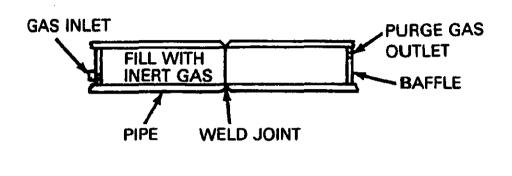
Pulsed DC advantages:

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

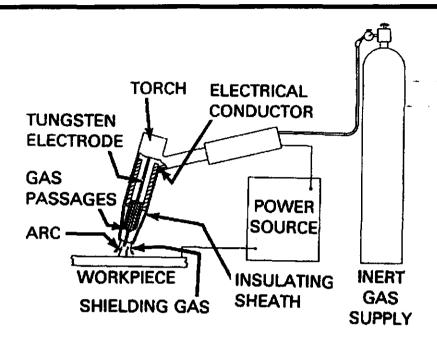
GTAW: Gas backing

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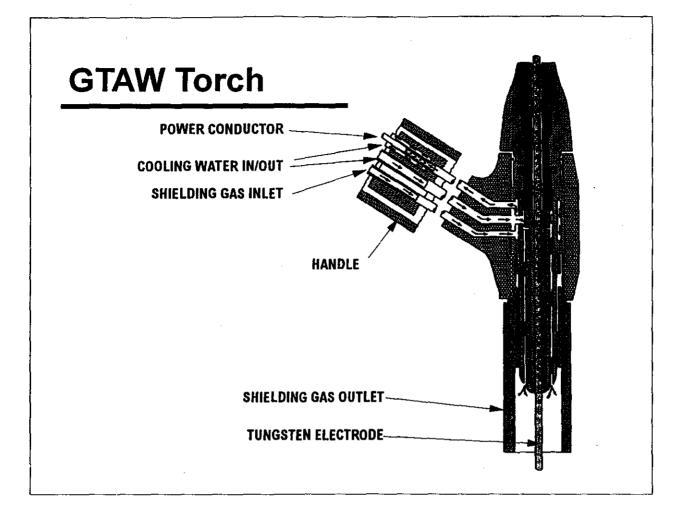
GTAW: Pipe internal purge



GTAW Equipment Schematic



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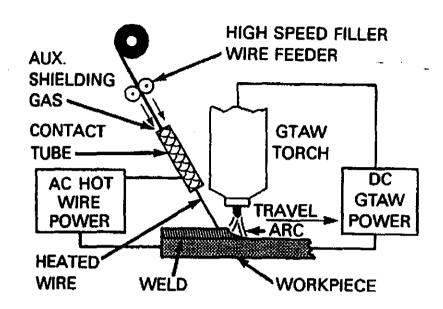
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Mechanized GTAW Applications

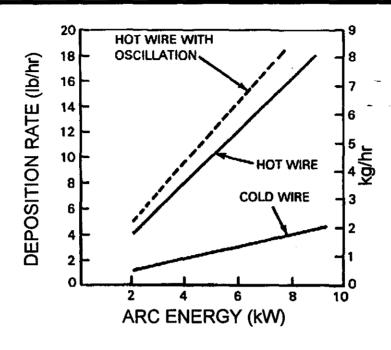
- Mechanization of
 - weld head travel motions
 - wire feed (if required)
 - process controls: start/stop sequence, weld current profile, shielding gas flow, etc
- Typical applications: Pipe, tube, tube-tubesheet welding, longitudinal welds in formed tubes.
- Advantages of mechanization
 - Increased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

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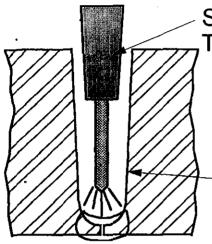
Hot Wire GTAW







Narrow-Gap GTAW



Special Narrow-Gap. Torch

Narrow-Gap Joint Preparation

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

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