

## **Gas Shielded Welding Processes**

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# **Plasma Arc Welding (PAW)**

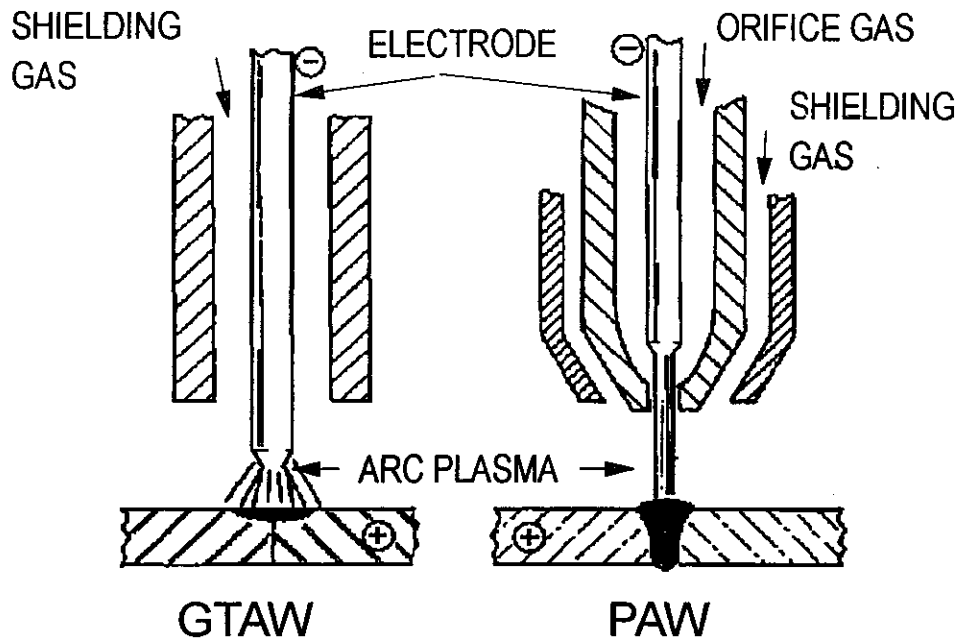
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# **PAW: Process Fundamentals**

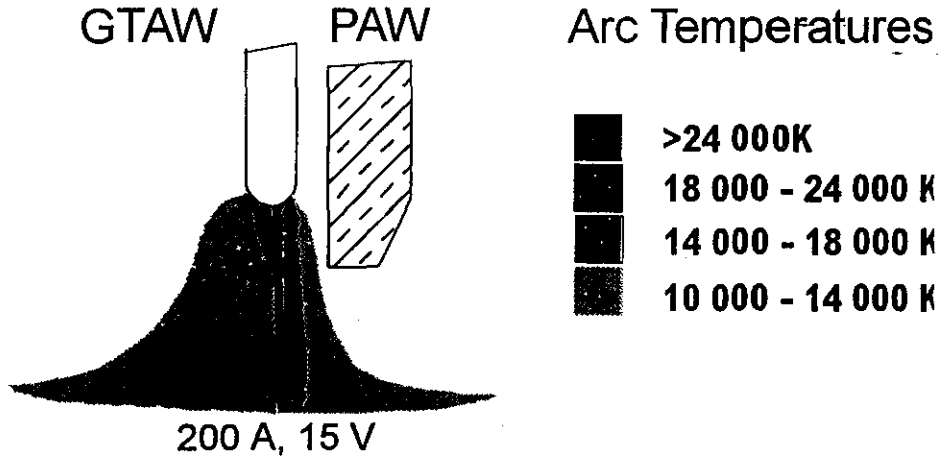
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- In PAW the heat source is an arc maintained between a non-consumable electrode and the workpiece
- The arc is constricted by a cooled orifice that surrounds the electrode
- Inert gas is supplied separately to the orifice and to a surrounding low-velocity shielding flow

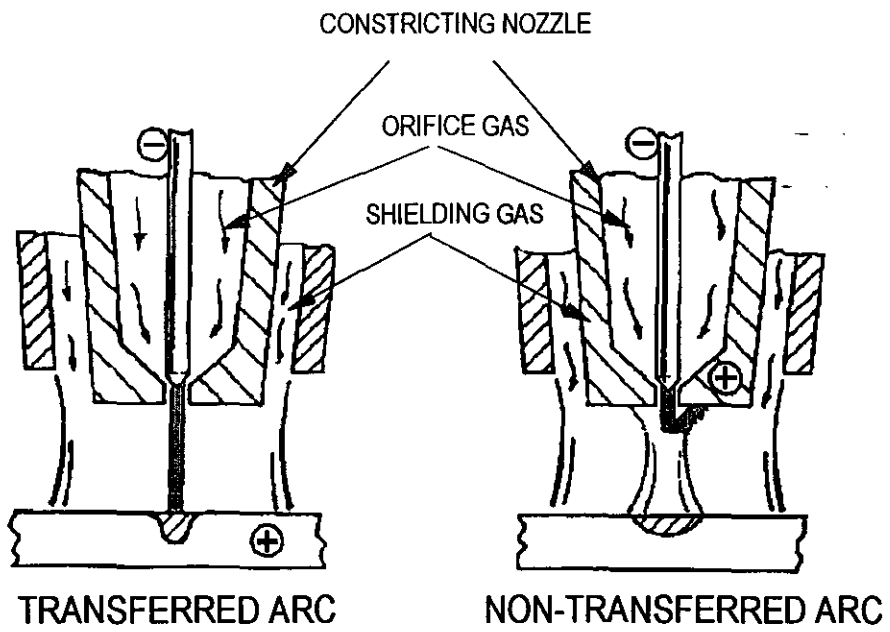
# PAW: Comparison with GTAW



# PAW: Effect of Arc Constriction

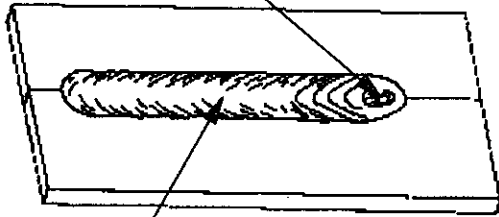


# PAW Modes



# PAW: Keyhole technique

KEYHOLE



WELD BEAD

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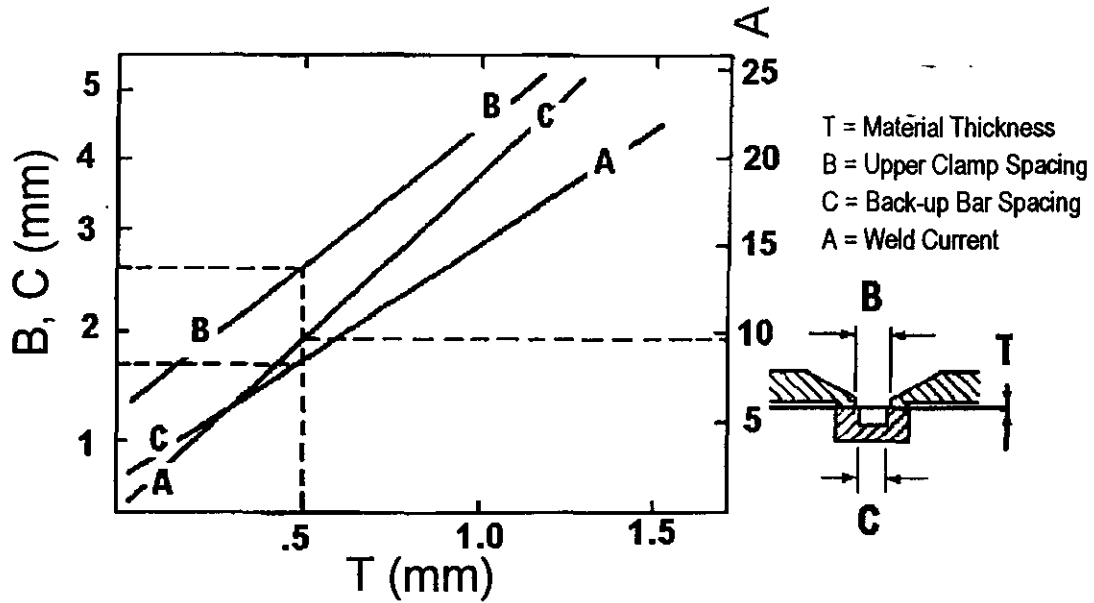
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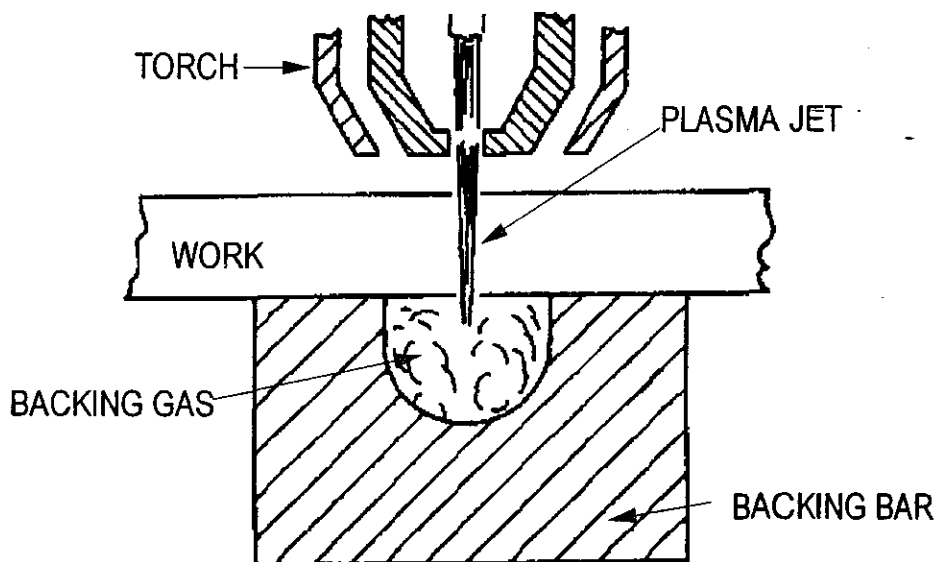
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# PAW: Welding Procedures

Keyhole welding of stainless steel sheet



# PAW: Backing for Keyhole Welding



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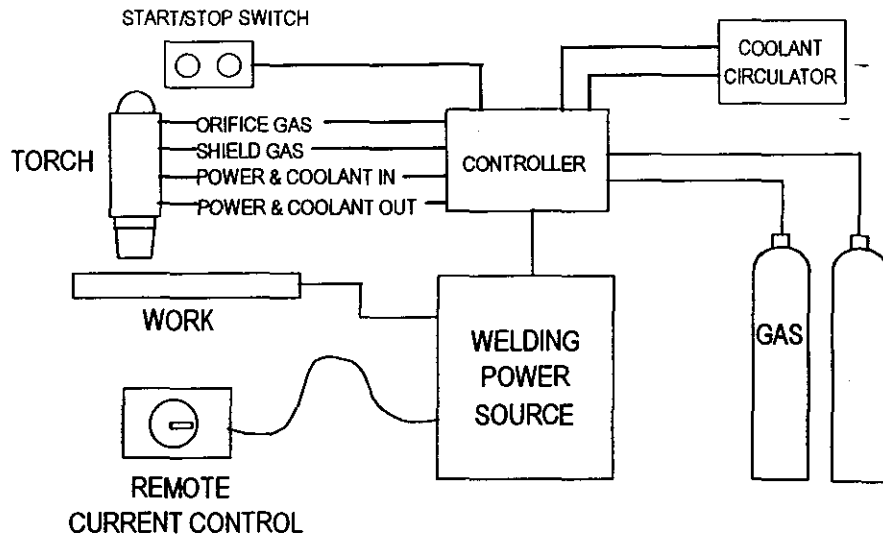
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# PAW Welding Equipment





## **PAW Applications**

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- Very thin sheet (down to 0.1 mm), wire and mesh sections in microplasma mode
- Full penetration welding of sheet and plate up to about 5mm thick in single pass keyhole mode.
- Keyhole mode usually in flat position, rarely for tube and pipe welding
- Melt-in mode applications similar to GTAW

# **PAW Capabilities & Limitations**

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| <ul style="list-style-type: none"><li>+ Higher intensity heat source than GTAW<ul style="list-style-type: none"><li>- higher welding speeds</li><li>- reduced heat input and distortion</li></ul></li><li>+ Insensitive to torch stand-off distance</li><li>+ Applicable to almost all metals</li><li>+ Adaptable to precision mechanized applications</li></ul> | <ul style="list-style-type: none"><li>- Little tolerance for joint misalignment</li><li>- Torch orifice must be well maintained for consistent weld quality</li><li>- PAW torches are more bulkier and more difficult to manipulate manually than GTAW</li></ul> |
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# **Electron Beam & Laser Welding**

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# EBW, LBW Fundamentals

- Heat source is radiant energy from focused beam of electrons or photons (light)
- Shielding from atmospheric contamination by welding in vacuum chamber (EBW), inert gas shield (LBW)

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# LBW, EBW Capabilities and Limitations

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| <ul style="list-style-type: none"><li>+ Very high energy density heat sources</li><li>+ Very deep penetration in "keyhole" mode</li><li>+ Narrow welds and HAZ</li><li>+ High welding speed</li><li>+ Reduced heat input and distortion</li><li>+ Adaptable to precision mechanized applications</li></ul> | <ul style="list-style-type: none"><li>- Little tolerance for joint misalignment</li><li>- EBW requirement for vacuum chamber limits maximum size that can be welded</li><li>- Equipment is complex and costly.</li></ul> |
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*LBW: High speed, shallow penetration, EBW*