Double-Electrode Gas Metal Arc Welding

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Motivation

GMAW: melting current=base metal current

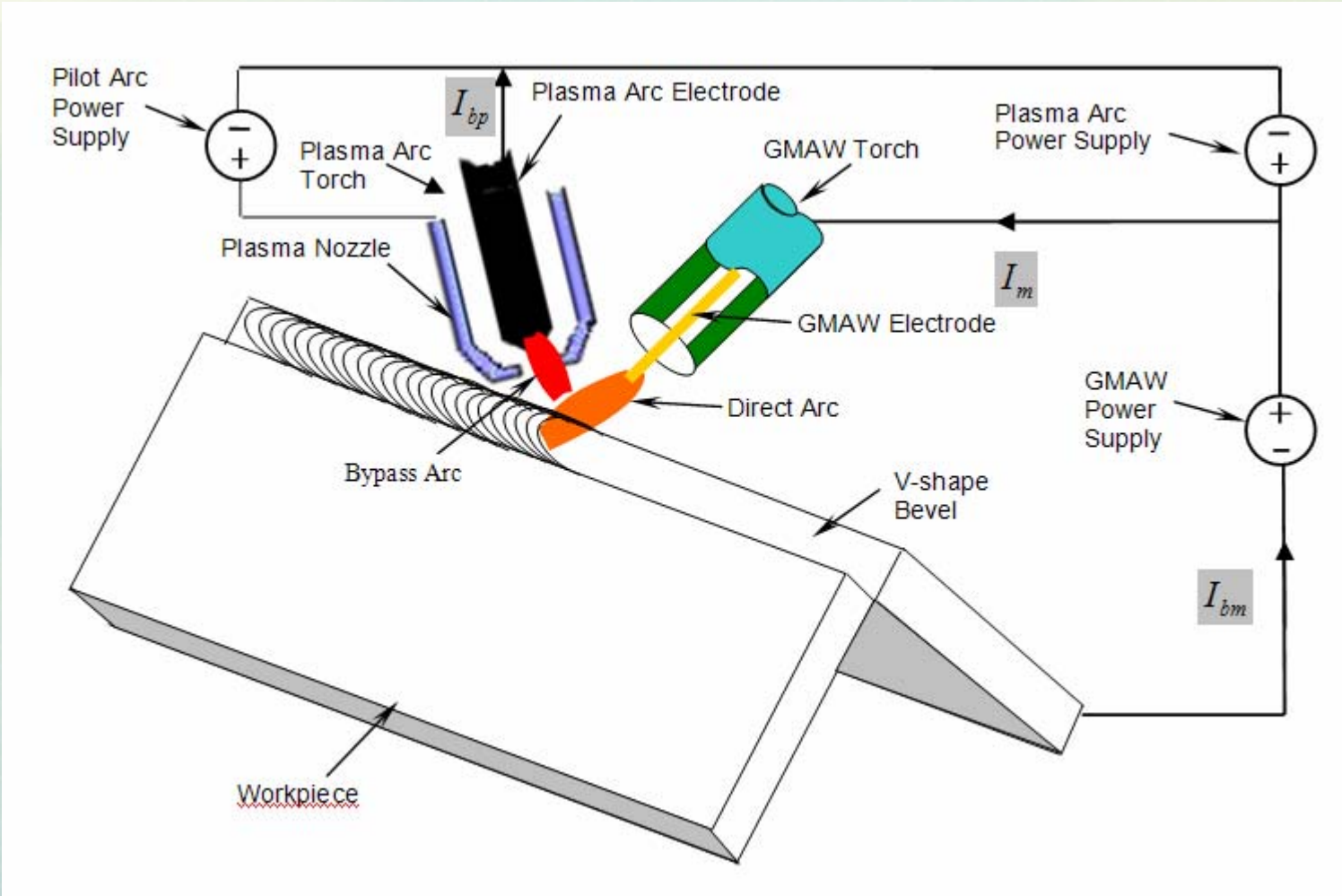
Problem: increase current➔ increase deposition➔ increase heat input, distortion and arc pressure

Solution: make melting current > base metal current

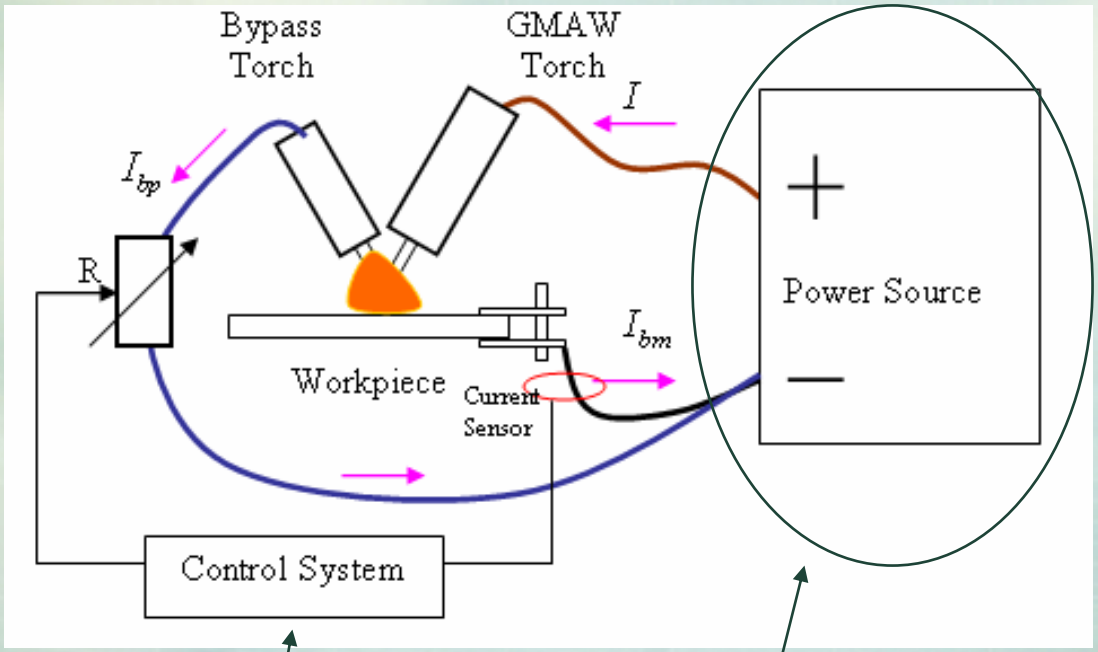
melting current can be increased freely while the base metal current is controlled at the desired level

Double-electrode Gas Metal Arc Welding (DE-GMAW)

Early Implementation Using Two Power Supplies



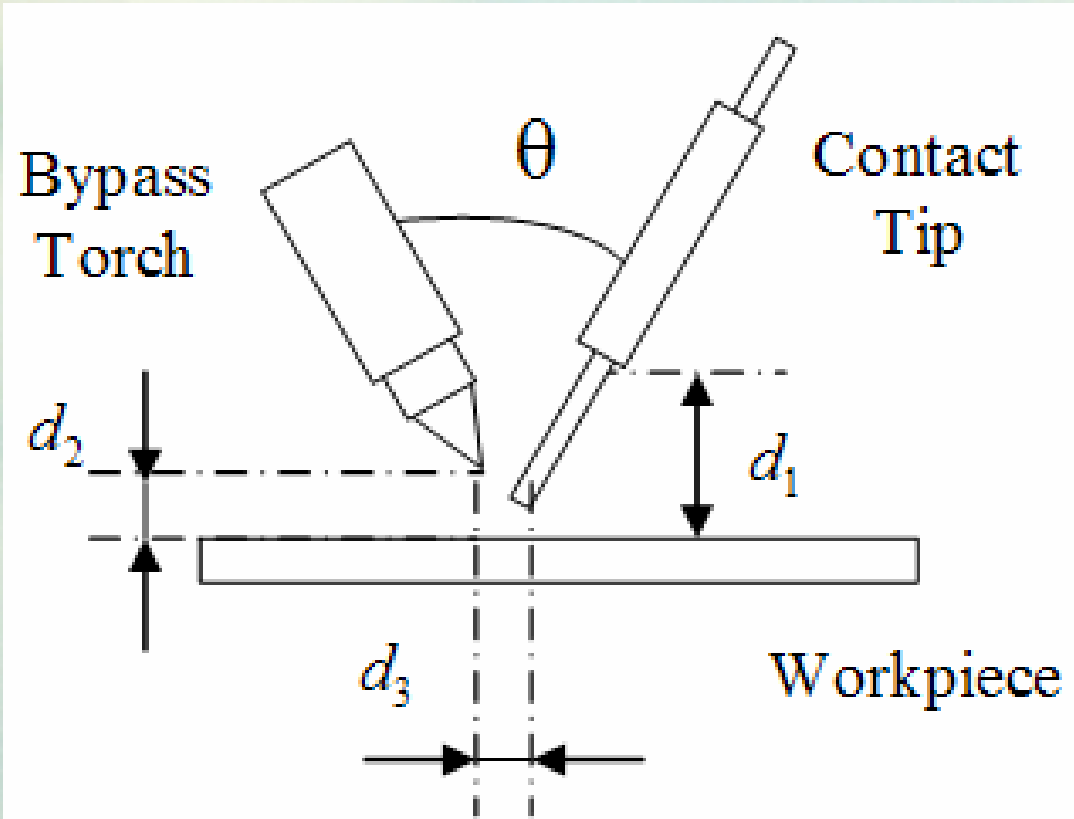
Single Power Supply System



Just one power supply

Control the base metal
current at the desired level

Stable Process



Optimal values:

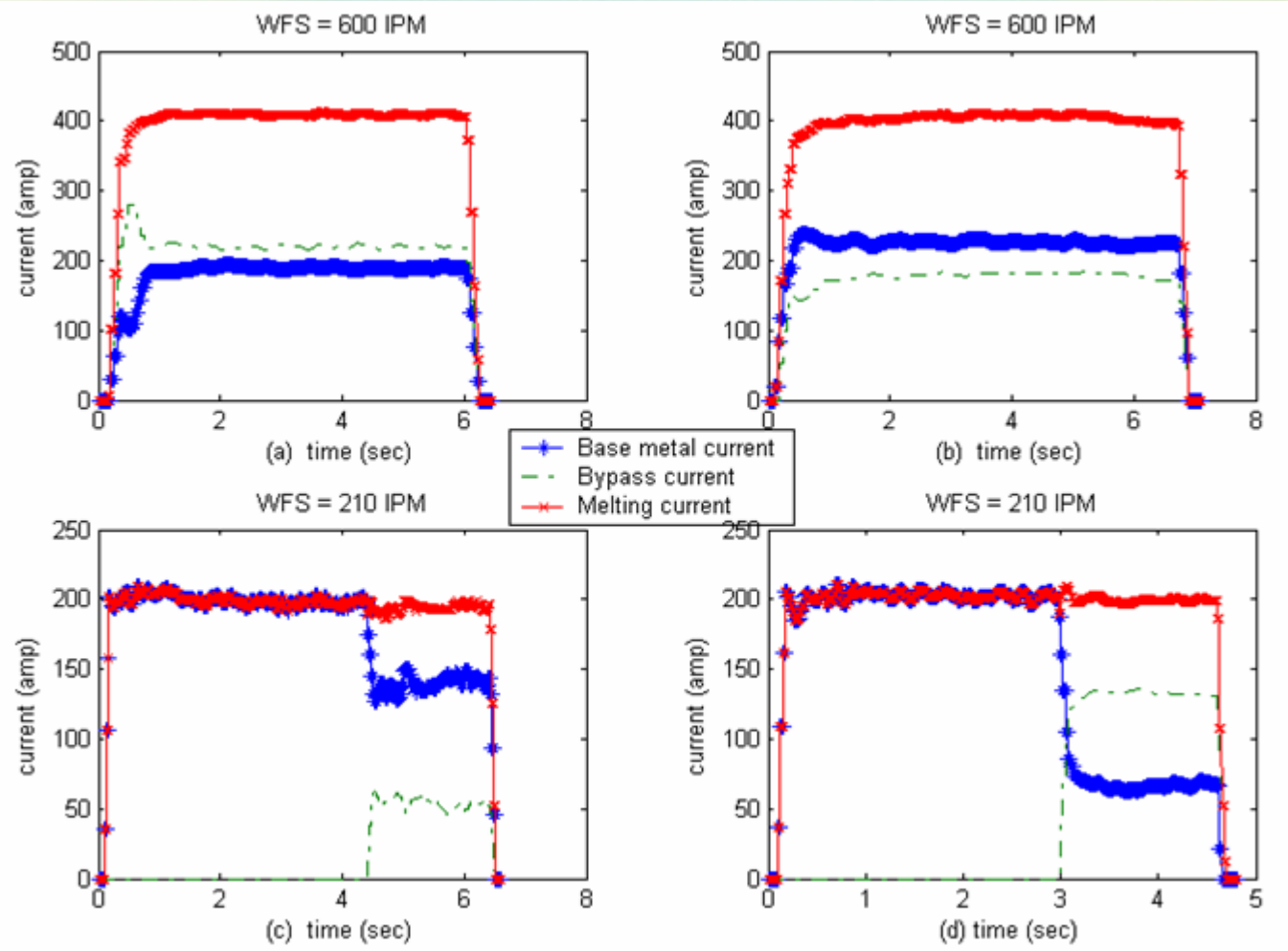
d_1 : 20mm

d_2 : 6 mm

d_3 : 2mm to 5 mm

θ : 60 degrees

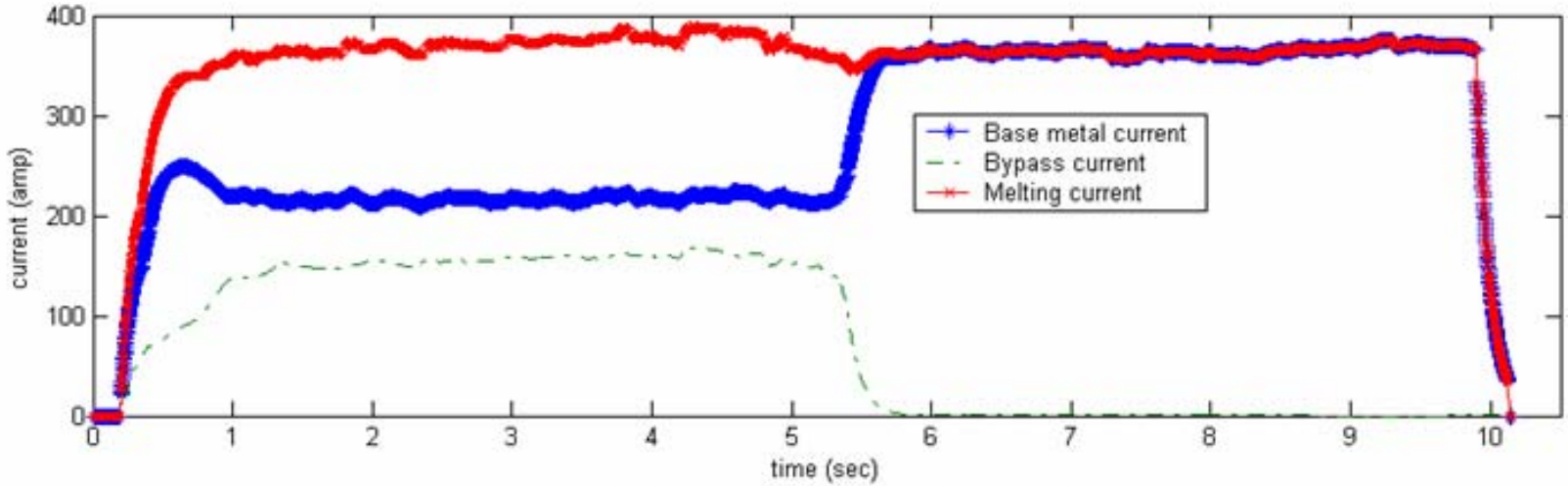
Free Control of the Base Metal Current



Currents monitored in DE-GMAW

Double Travel Speed for Sheet Metal Welding

Lap joint



Current monitoring for lap joint

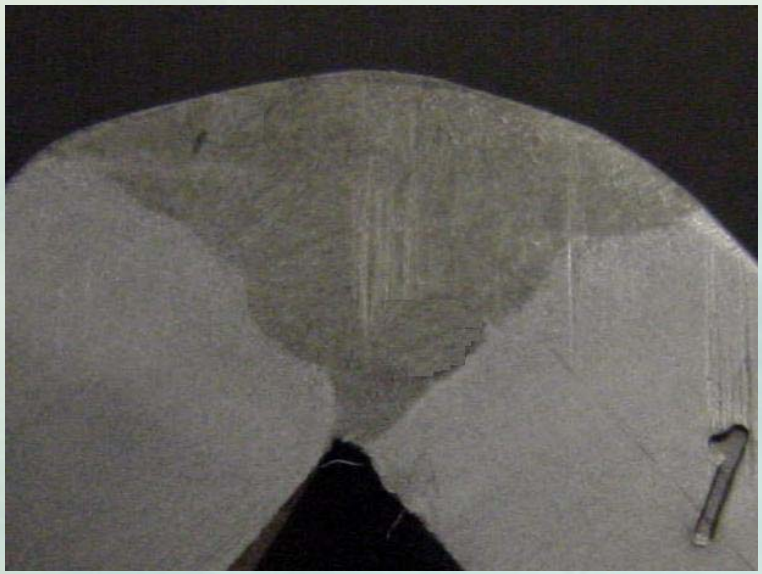
Weld examples demonstrating bypass arc's effect. TS = 1.65 m/min (65IPM), WFS = 13.97 m/min (550IPM), I_{bm} = 220amps

145		base metal current (amps)
30		voltage (volts)
4350		power (watts)
6.6		travel speed (in./min)
39.54545		heat input (kJ/in)

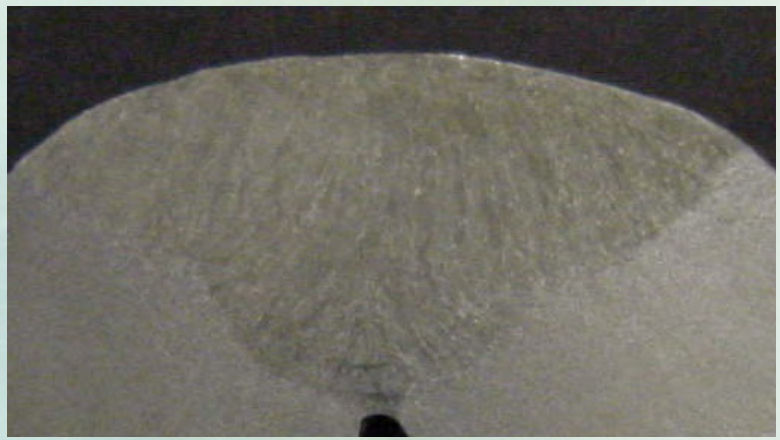
½ in. Plates

Fill Pass: single

Experiment #	I_{bp} Setting	I_{bm} Reading	Travel Speed	Wire Feed Speed	Number of DE-GMAW Passes	Results
1	100 A	145 A	6.6 in./min	500 in./min	1	Sufficient Bond
2	70 A	185 A	6.6 in./min	500 in./min	1	Sufficient Bond
3	0	250 A	6.6 in./min	500 in./min	1	Burn-Through



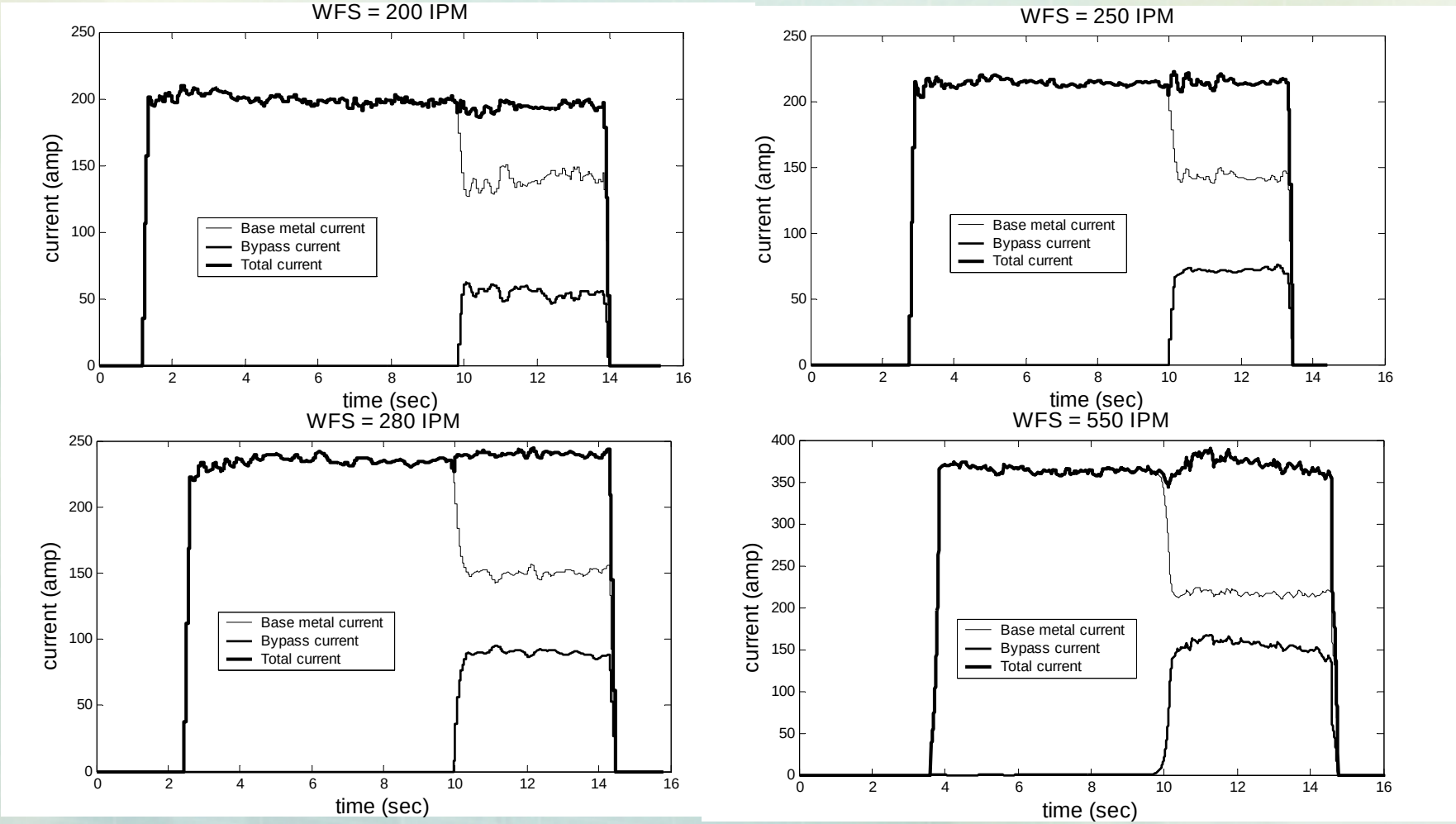
Experiment 1



Experiment 2

Arc and Metal Transfer

Effect on Total Current: Not At All



Effect on Metal Transfer Mode and Droplet Size

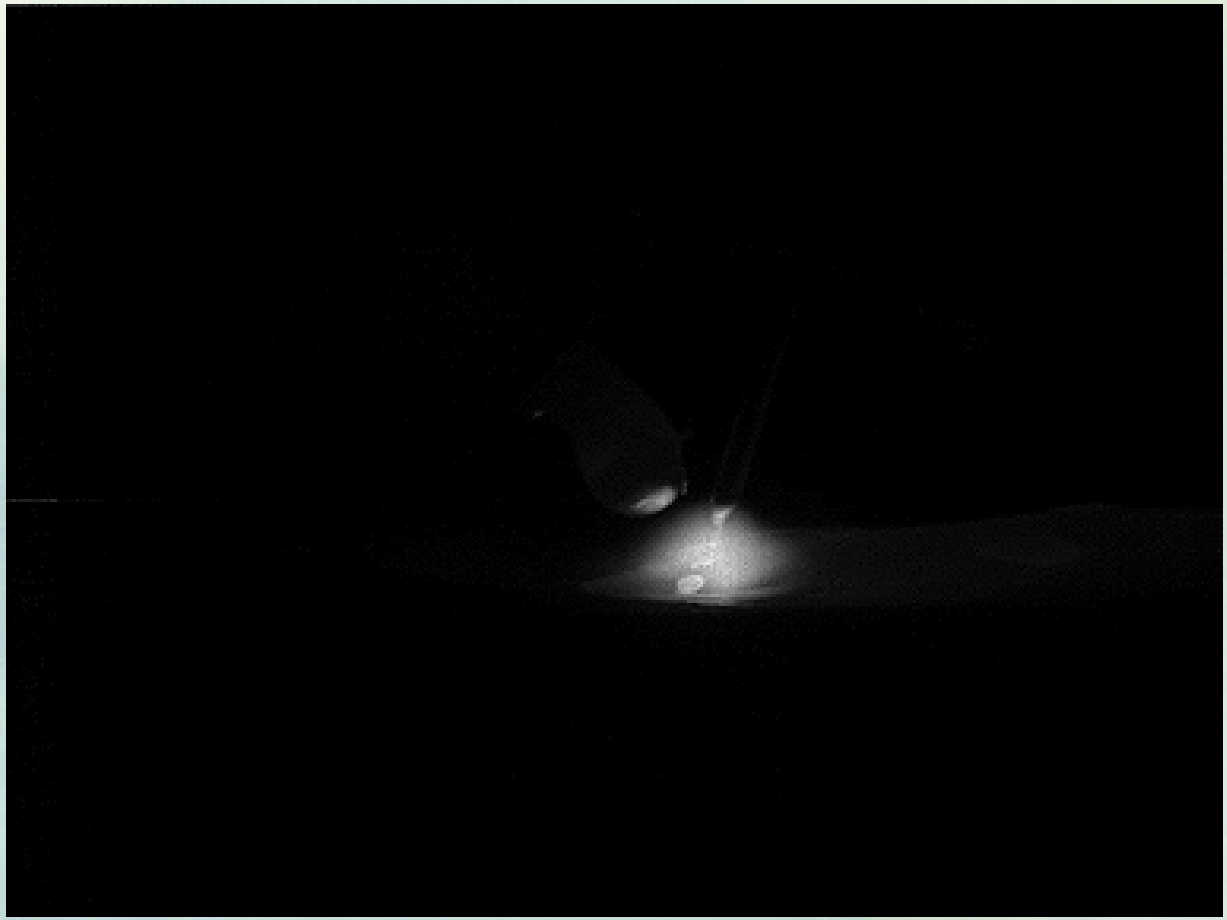
(a) Bypass current = 0

(b) Bypass current = 72 amps

(c) Bypass current = 108 amps

Metal Transfer Experiment. WFS: 6.4 m/min (250 IPM). Total Current: 215 amps

Effect on Process Stability and Metal Transfer



Conclusions

- **Base Metal Heat Input = Desired, Melting Rate = Increased** (or unlimited if torch and power supply permit);
- **Feedback Control of Base Metal Current;**
- **Any Single Existing CV Power Supply;**
- **What Added: a GTAW torch, a Controller** (no parameters to set), **A Current Sensor.** (for example, Program 230 for base metal current =230 amps; Program 250 for base metal current=250 amps)
- **Thin sheets: increased welding speed, reduced base metal heat input, reduced distortion;**
- **Thick sections: (unchanged base metal heat input but reduced the number of passes) or (unchanged number of the passes but reduced base metal heat input and distortion);**
- **More stable process and reduced amount of spatters.**

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- Daniel Hartman (Los Alamos National Laboratories): “GMAW Brazing of Aluminum” (March 2006-March 2007)