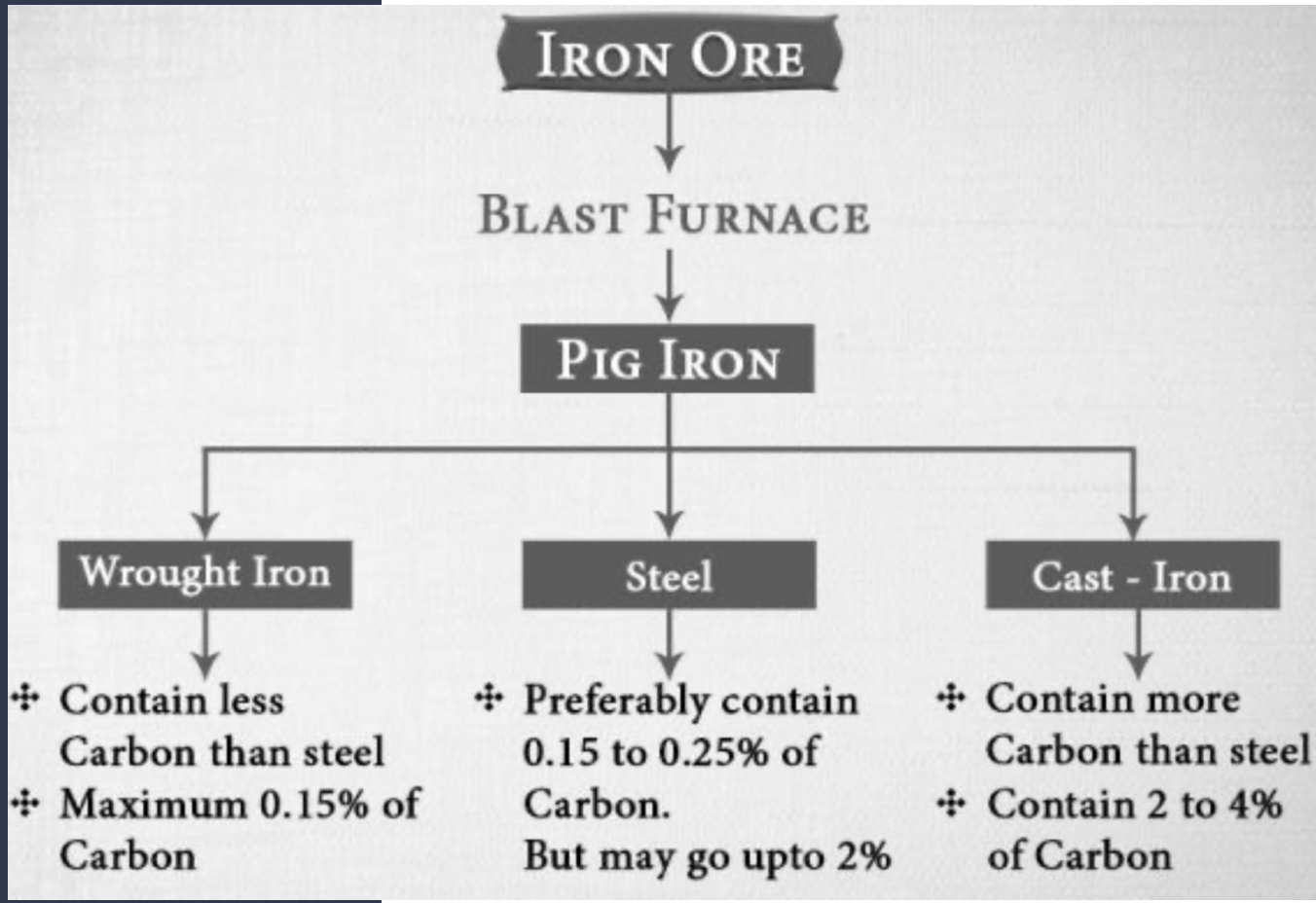
# A Brief History of Metalworking

- 3300 BC
  - Earliest examples of welding: Egyptian pressure welded box
- 1200 BC
  - Egyptians begin welding iron
- Middle Ages
  - Forge welding evolves using  hammering techniques
- 1800
  - An arc between two carbon electrodes is created by Sir Humphry Davy and stabilized in 1802 by Vasily Petrov
- 1881
  - Carbon arc welding introduced by Russian inventor Nikolay Benardos
- 1900
  - Coated metal electron introduced
  - Gas welding perfected
- 1920
  - Automatic feed electrode introduced by P.O. Nobel at GE
- 1941
  - GTAW (Gas Tungsten Arc Welding)/TIG Welding perfect after years of development
- 1948
  - GMAW (Gas Metal Arc Welding)/MIG developed by combining shielded gas nozzle and automatic feed
- 1957
  - Plasma arc is discovered and applied to welding and cutting processes

# Mild Steel

# What is mild steel?

Mild steel is a ferrous metal alloy made of iron and carbon. The carbon content of mild steel is very low, any higher and it would be considered cast iron. The particular balance of iron and carbon allows for high ductility, machinability and weldability which makes mild steel perfect for many general fabrication applications.



# How do we fabricate with mild steel

There are four main things we will commonly do with mild steel to make new objects, to simplify;

- Cutting
- Shaping
- Joining
- Finishing

# Cutting

Cutting steel is done to shape the material into parts we can use. This is commonly done in a few ways;

- Abrading ( Cut off Wheel, Abrasive Chop Saw)
- Cutting (Cold Saw, Bandsaw, Shear, Throatless Shear, Tin Snips, Nibbler)
- Melting (Plasma Cutter, Laser Cutter)

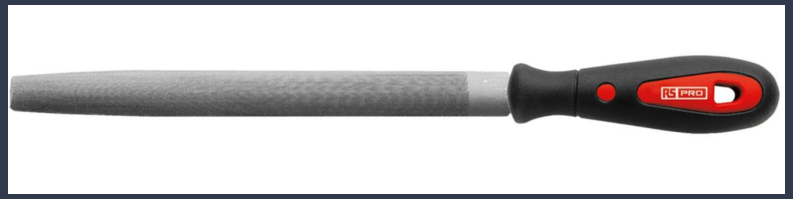
# Shaping

Shaping is done with a variety of tools and methods;

- Simple Shaping (Brake, Flat Roller and Rod Bender)
- Compound Shaping ( English Wheel, Smithing, Pressing, Spinning)
- Hot Shaping (heat assisted)

# Joining

- Hot Connections
  - Welding
- Cold Connections
  - nuts and bolts
  - Rivets
    - Solid Rivets
    - Pop Rivets


# Finishing

Finishing for steel is generally done in two stages;

- Sanding and Polishing (Grinder, Sander, Buffing Wheel, Sand Blaster, Tumbler)
- Additive Finishing (Waxing, Chemical Patina, Powder Coating, Painting, Plating)


GRINDING WHEEL
FLAP DISC
RESIN FIBER DISC
WIRE WHEEL BRUSH
CRIMPED WIRE CUP BRUSH

# Grinding

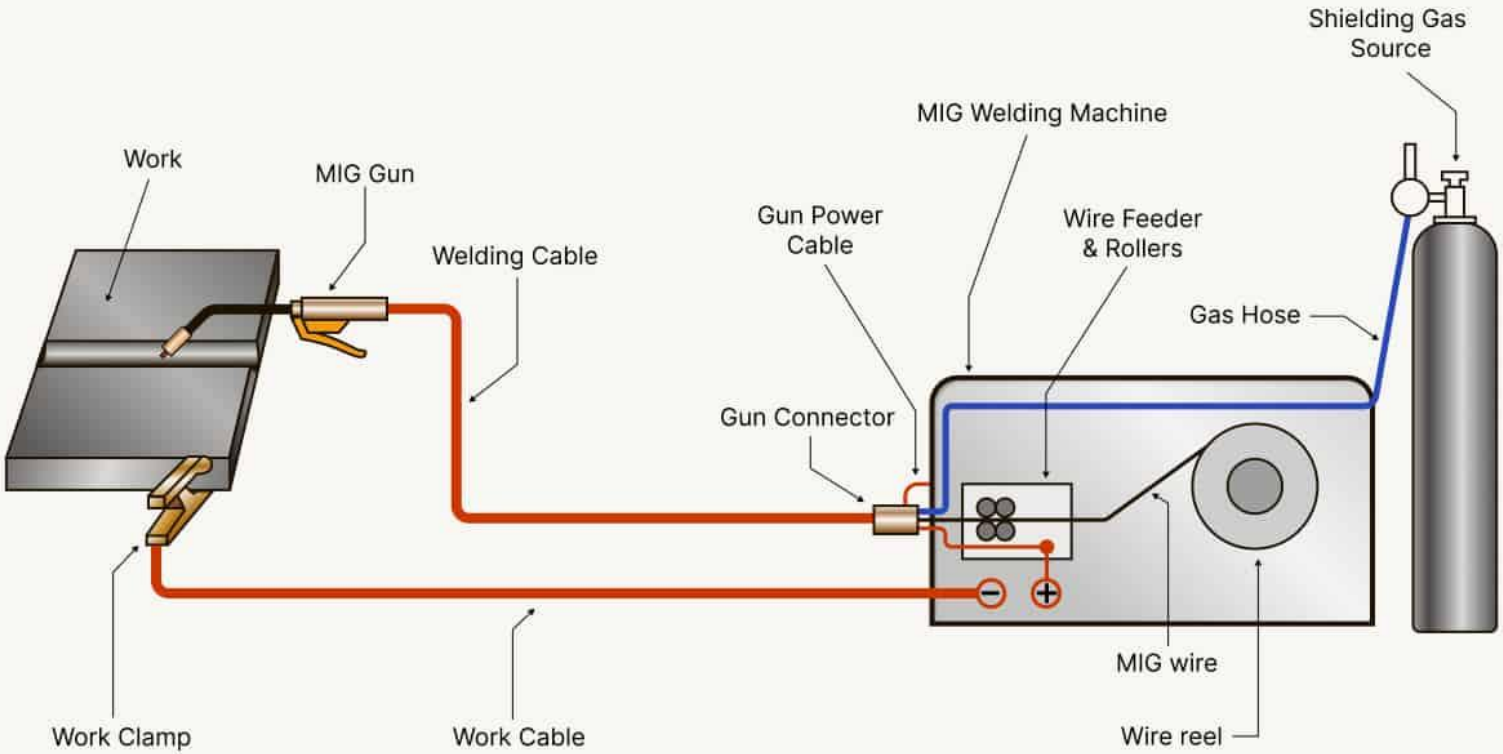
# Mig Welding

Metal

Inert

Gas

# MIG Welding Setup



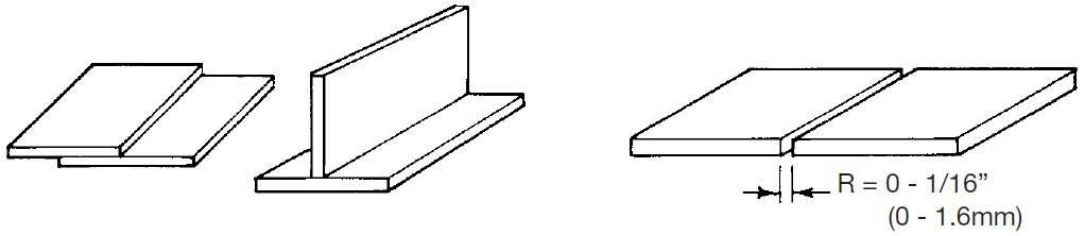
# Welder Settings

# General Welding Guidelines

## Welding Guidelines for Carbon and Low Alloy Steel

### Welding Guidelines for Carbon and Low Alloy Steel
### Short-Circuiting Transfer — Horizontal Fillets and Flat Butt Joints

CTWD[1] : 1/2" (13mm)
Gas: 100% $CO_2$
Gas flow: 25 to 35 cfh
(12 to 17 L/min.)




| Plate Thickness - (mm) | 24 ga (0.6) | | 20 ga (0.9) | | 16 ga (1.5) | | 14 ga (2) | | 12 ga (3) | | 10 ga (4) | | | 3/16" (5) | 1/4" (6) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Electrode Dia. - in. (mm) | 0.025 (0.6) | 0.030 (0.8) | 0.030 (0.8) | 0.035 (0.9) | 0.030 (0.8) | 0.035 (0.9) | 0.030 (0.8) | 0.035 (0.9) | 0.030 (0.8) | 0.035 (0.9) | 0.030 (0.8) | 0.035 (0.9) | 0.045 (1.1) | 0.045 (1.1) | 0.045 (1.1) |
| WFS - in./min (M/min.) | 100 (2.5) | 75 (1.9) | 125 (3.2) | 100 (2.5) | 175 (4.4) | 150 (3.8) | 225 (5.7) | 175 (4.4) | 275 (7.0) | 225 (5.7) | 300 (7.6) | 250 (6.4) | 125 (3.2) | 150 (3.8) | 200 (5.0) |
| Amps (Approximate) | 35 | 35 | 55 | 80 | 80 | 120 | 100 | 130 | 115 | 160 | 130 | 175 | 145 | 165 | 200 |
| Travel Speed - in./min (M/min.) | 10 (0.25) | 10 (0.25) | 14 (0.35) | 13 (0.33) | 13 (0.33) | 20 (0.50) | 18 (0.45) | 18 (0.45) | 20 (0.50) | 20 (0.50) | 17 (0.43) | 20 (0.50) | 18 (0.45) | 15 (0.38) | 13 (0.33) |
| Voltage [2] (DC+) | 17 | 17 | 18 | 18 | 19 | 19 | 20 | 20 | 21 | 21 | 22 | 22 | 18-20 | 19-21 | 20-22 |

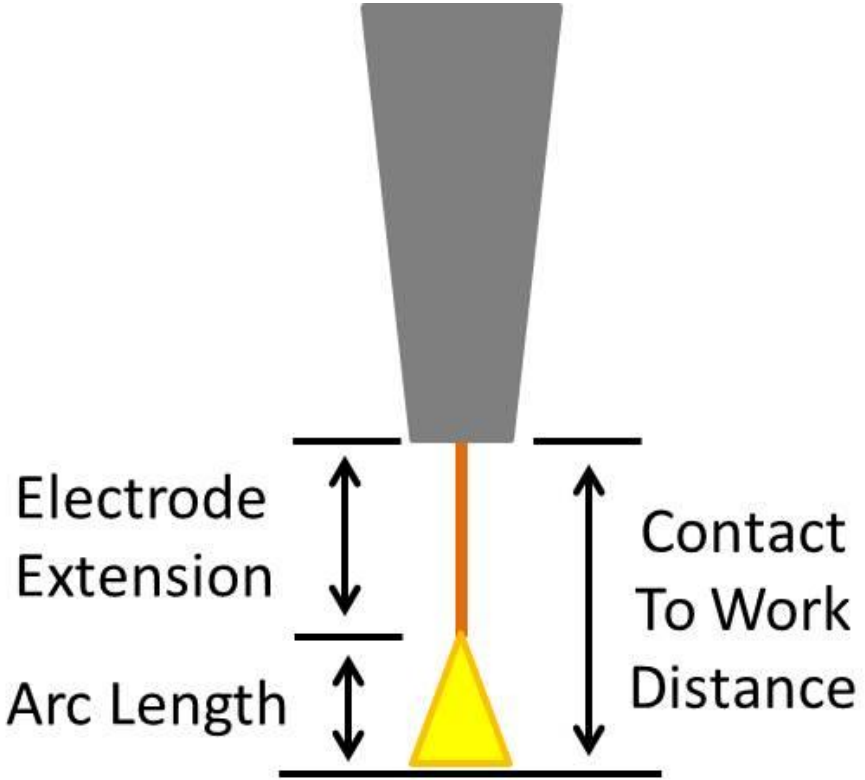
# Contact to Work Distance

½” – ⅝”

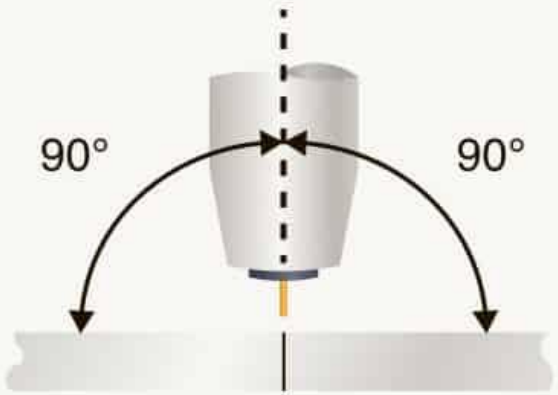
# Electrode* Extension

¼” – ⅜”

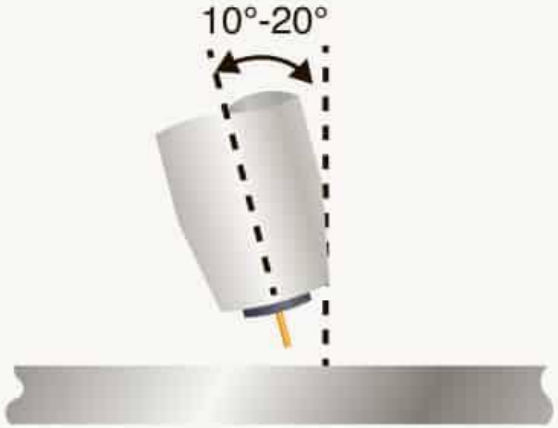
*welding rod or wire



# Butt Joint Angle

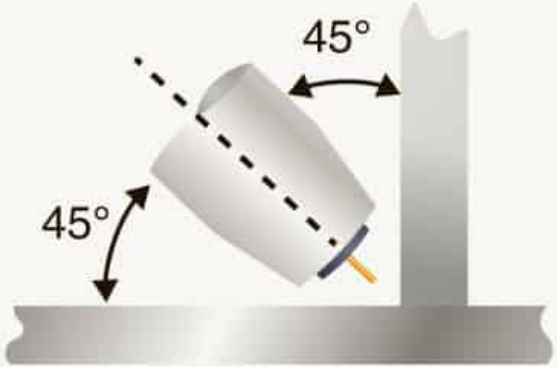


Joint Angle

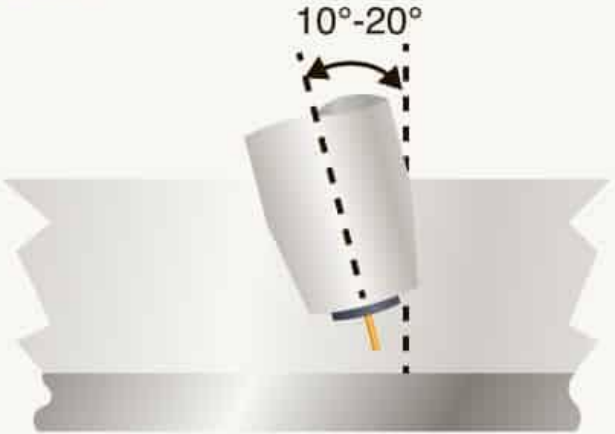


Travel Angle

# Fillet Joint Angle

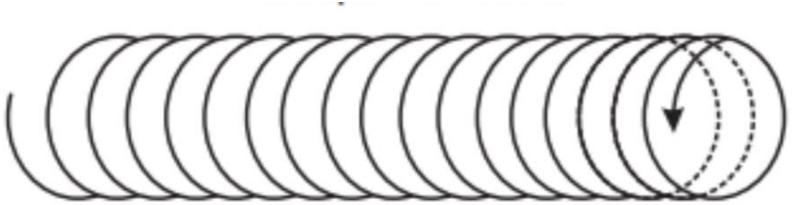


Joint Angle



Travel Angle

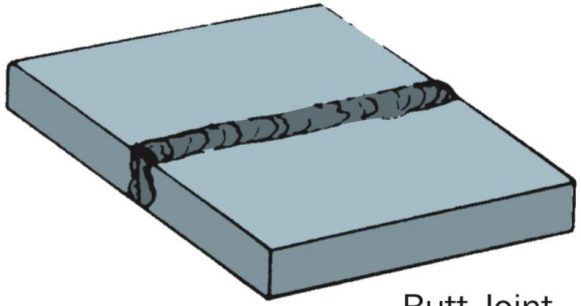
Semicircular Motion



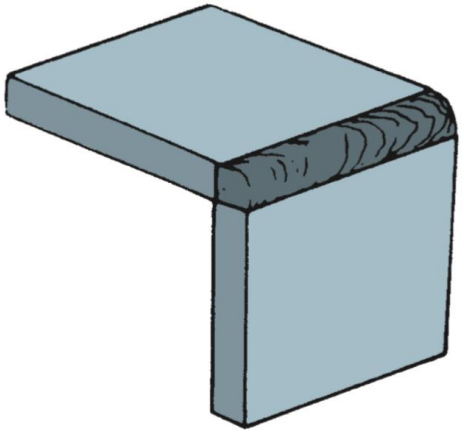
Circular Motion

# Weave Movements

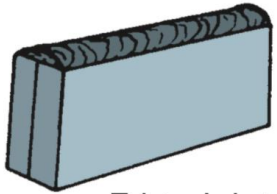
# Types of Welds



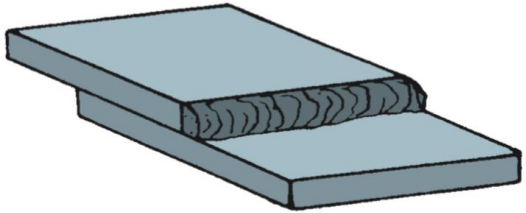
Butt Joint



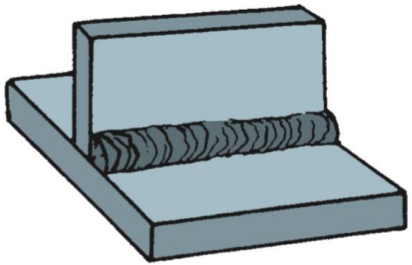
Corner Joint



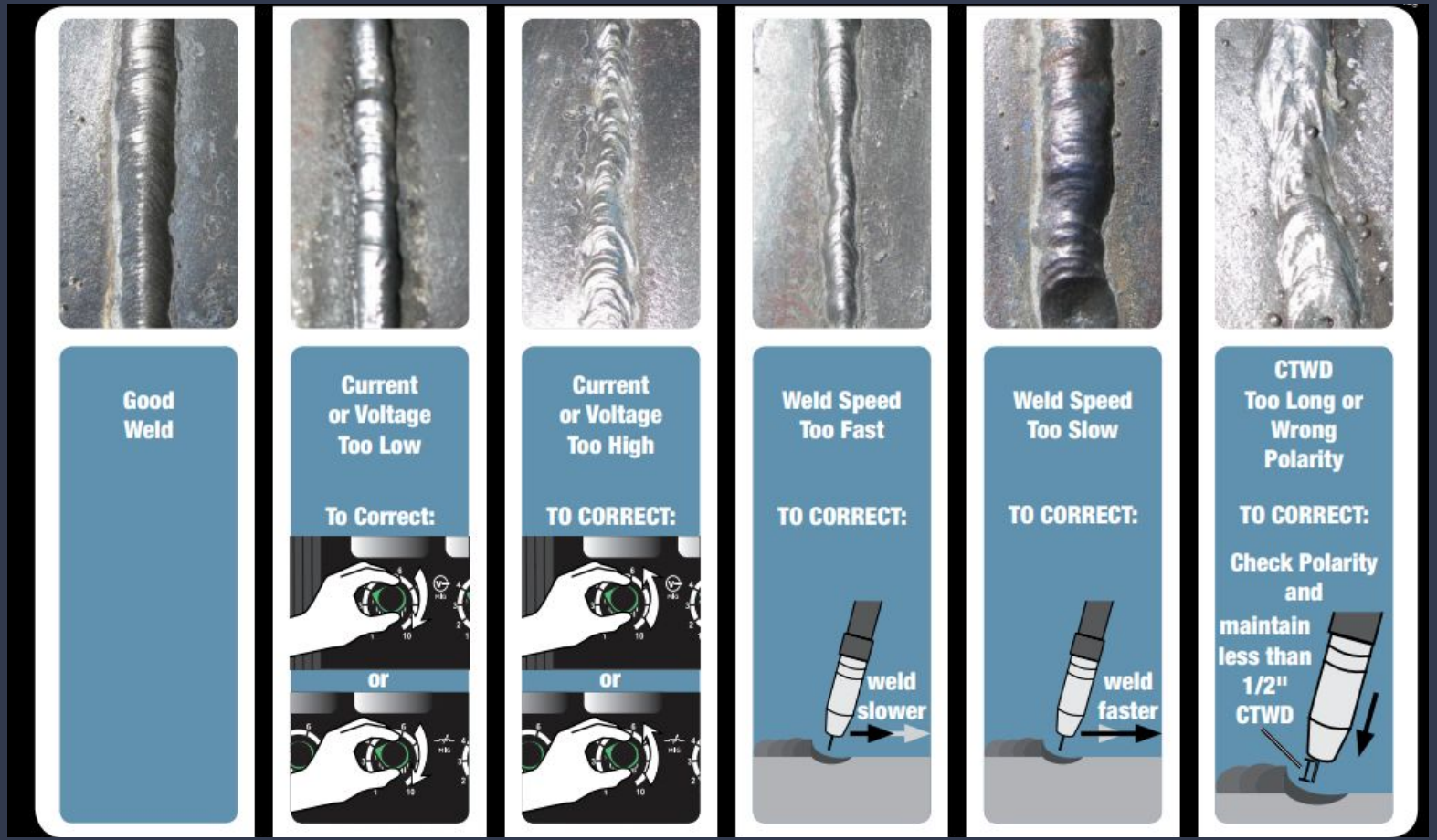
Edge Joint



Lap Joint



Tee (Fillet) Joint




# Weld Troubleshooting