Getting Started with Welding

With the biochar crew at Living Web Farms

Introduction

Who we are

What we're going to talk about:

- Basic concepts of working with metals, predominantly steel
- How to protect yourself and others when working with steel
- Cutting techniques and methods for preparing your work prior to welding
- Stick welding, mig welding

What we're not going to talk about:

- Anything advanced, or beyond entry level: TIG, aluminum welding
- Compared to playing piano - we're just going to learn chopsticks

What is welding

- Fusion - heating of parent material - actual melting. Our process adding new material "filler"
- As opposed to: Soldering/brazing - no melting of parent material. Or any process where no filler material is used.
- Requires high control and localized heating.
- Parent material must be clean, and stay clean, during welding process.

Metals

- Malleable, shiny, conduct electricity and relatively high melting point
- Pure elements: copper, tin, aluminum, iron, zinc, gold, and more
- Alloys - mixture of metals, sometimes with non-metals, still maintains a metal bonding character. Nearly universal. Rare to find anything that's single element
    - Adding different elements give metals wildly different characteristics.
    - Gold - 24 carat is pure. Much too soft
    - Brass - copper and zinc. Bronze - copper and tin.
    - Steel - varying degrees of carbon
        - Iron - blacksmiths say it's like 'butter'. Self-fluxing to some extent
        - Mild steel - most common. nails
        - Med - axles
        - High - springs
        - Very High - files
        - Pattern: increasing hardness, decreasing 'toughness'. Simple scratch test.
    - Cast iron - 2-4% carbon. Very brittle, with low melting point. Doesn't tend to change shape with heating. Requires lots of preheating to weld
    - Stainless - 10% chromium by minimum. Resistant to oxidizing. High heat tolerances.

Working with Steel

- Different materials w/ different melting points
    - Lead - 327F, Aluminum - 1218F, Cast Iron - 2200F, Steel - 2500F
    - Lots of heat - tightly controlled and very localized
    - Smaller pieces, require less heat. Too much and burn.
    - Larger pieces, require more heat. Too little and no weld penetration

- Rapid cooling: hardens steel. Slow cooling: 'annealing' softens steel
    - Actual crystalline structure of the steel changes
- Tempering - process of dialing in desired toughness and hardness with controlled cooling.
    - Oftentimes a single piece may have a gradient temper. Knife edge for example.
    - "Losing your temper"
- Stress hardening - moving steel without heating, hardens joints and will eventually break. Think about bending a paper clip

Finding steel

Big Box hardware store - VERY expensive way to buy steel

Steel Supply -

- Specific nomenclature. Walk in's OK.
- "Full stick" 20'. Pipe 21'
- Cut charges add up. Some guys will do a 'courtesy' cut.
- Usually paying for weight. Sometimes, for specialized manufacturing process (expanded steel)

Junkyard -

- Paying by weight.
- Big piles - steel pile. Cast pile. Stainless pile.
- Patience pays off

Safety

A whole bunch of hazards in a welding shop

- Cuts - sharp edges, burrs
- Impaling - maintain a clean floor, store steel on racks
- Shrapnel - maintain steady hand, clamp your work. Inspect cutting wheels
- UV burns - intense light from welding arc, quickly turns to sunburn
- Eyes - all of the above
- Gasses - flux, junkyard steel
- Airborne particles from prep work
- Burns - Slag, hot work. Not just you, but your property too!
- Electrical hazards

Cutting and prep (johnny)

Cutting steel

Removing material

Specific hazards

Tools:

Angle grinder

- Capable of completing all prep work.
- Almost always necessary at some point
- Cutting wheels - great for quick, small cuts.
- Grinding wheels - beveling, grinding welds, cleaning
- Cup brush - high speed brushing - removing paint and rust.

Bench Grinder

- Safer when used properly.
- Easier for small objects, work end pieces
- Beveling, cleaning edges, rounding edges

Portaband (show picture)

- No sparks
- Safer than angle grinder
- Very fast cutting.
- Difficult to manage square cut

Chopsaw

- Quick, square cuts

Plasma Cutter

- Quick, Clean cuts when used properly
- Requires little further prep
- Requires no prior cleaning
- Compressed air combines with electric arc to create super heated plasma

Oxy/Act torch

- Quick and clean - with practice…
- Little further prep req'd
- Convenient if setup is already req'd for welding.
- Portable

Stick Welding - Evan

- Power flow: Welder>electrode>work>ground clamp>back to welder
- Operator maintains a position between the work and an electrode, where a powerful electric current creates the “arc zone”

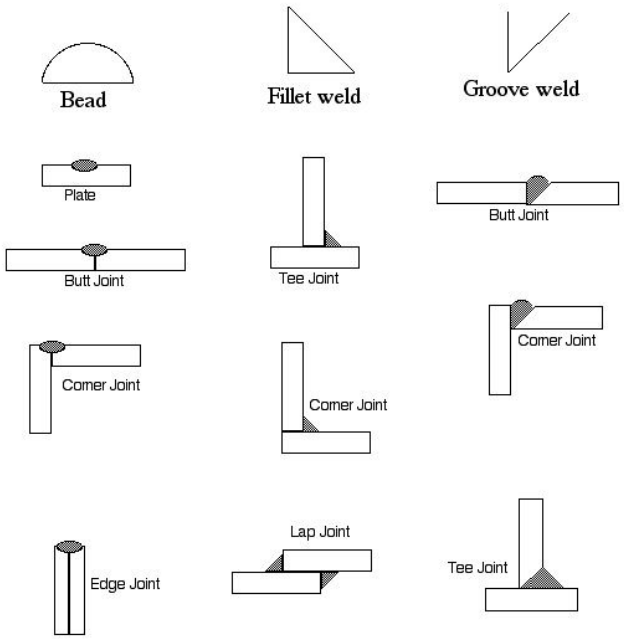
Arc zone

- Current arcs from ***electrode*** to work piece.
- Creates a lot of heat. >6000F
- Melts work and rod, deposits electrode as a ***weld bead***
- ***Flux*** from electrode vaporizes creating a gas shield around bead
- Gas shield protects weld from contamination (oxygen, water, etc) in air
- Flux solidifies on top of bead as ***slag***

Electrodes

- Metal wire with a flux coating
- Different diameters for different work
- Some are specific to certain welding positions: up, down, overhead, etc.
- Common electrodes:
  - 6011 - easy, any position, more splatter
  - 6013 - most positions, cleaner welds

Types of Welds



Common issues with stick welding:

- Getting started, striking the rod, and having it not stick
- Setting the proper voltage - can be easier to burn through work
- Maintaining integrity of rods - some are affected by moisture and must be stored in a sealed container

Wire Welding - Dan

Wire spool, long flexible conduit and gun

Similar to stick welding

- Still have to ground work, same safety issues
- Still have to maintain steady arc zone
- Easier to maintain control, operator's hand is closer to work

Two common types of wire welders:

- Flux-Core
    - Like stick electrodes, but flux is inside very hollow wire
    - Strong flux shield allows for welding in windy weather
    - Some very low cost 120V models available to get started
    - Deposits more slag and spatter than MIG
        - Requires more finish work
    - Smelly, smokey, requires better ventilation
- MIG (metal-inert-gas)
    - Uses separate tank of compressed shielding gas
        - argon/co2 mix
    - Cleaner welds, less spatter
    - Better for indoor use, non-windy days
    - Commonly in 240V models, more powerful
    - Most will double as flux-core welders too

Common welding mistakes

- Poor surface prep - work is dirty, oily, painted, weak connection to ground
- Know what you're welding. Never weld to a tank
- Too little/too much shield gas pressure
- Incorrect settings on welder, polarity
- Improper selection/care of electrodes and wire
- Push/pull techniques
- Base metal may be too 'far gone'

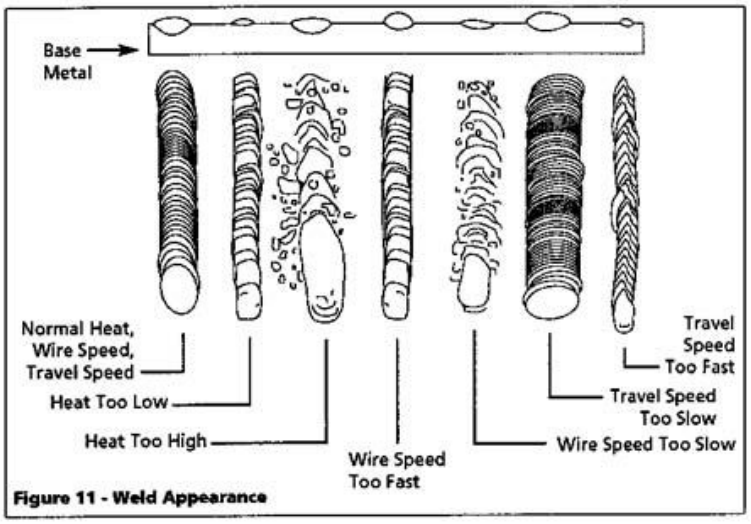


Figure 11 - Weld Appearance