IME 100 - WELDING

BASIC CLASS NOTES **NOVEMBER 16, 2015**

Reading Review and Class Preparation
This should be filled out prior to class.

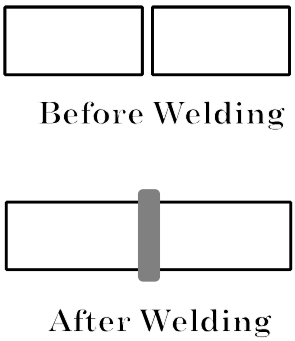
Key Concepts to Be Discussed in Class:

Questions About Subject Matter for Class Session:

So What? Why? Who Cares?

- Quite often Making Something Requires Joining the Pieces Together
- Techniques other Than Mechanical Fastening are Often Used

- A Problem Correctly Stated is a Problem Half Solved
  - Charles Kettering

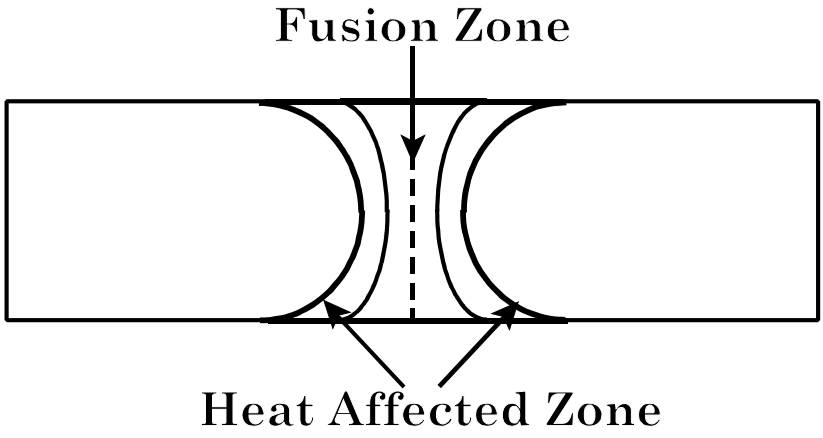


Definition of Welding

- Welding is a Fusion Joining Process
- In Metals
  - Both the Filler Metal and Base Metal Melt
- Weld Design Requires
  - Ensuring Melting
  - Ensuring Joining
  - Minimizing Effects

Parts/Zones of a Welded Joint

- Fusion Zone
  - Metal Quickly Solidifies
- Heat Affected Zone
  - Solid Metal "Annealed" Due to Heat Transfer



Concept Question

- Consider the Following Material Facts
  - Heating a Material Reduces Strength Both Before and After Cooling
  - Materials Which Solidify Quickly are Stronger
  - During Welding the Weld Pool Must Not Oxidize
- How Does This Effect Welding?

- What Must Be Done for a Good Weld?

- What is a Good Weld?

Melting

- Sufficient Energy Must Be Provided to Melt the Required Amount of Metal

Freshmen Experience

- Two Pieces of Steel
- Flame Welded (No Filler Metal)
- Dimensions
  Length = 1.5"
  Width = 0.5"
  Thickness = 0.0625"

Heat and Power Sources

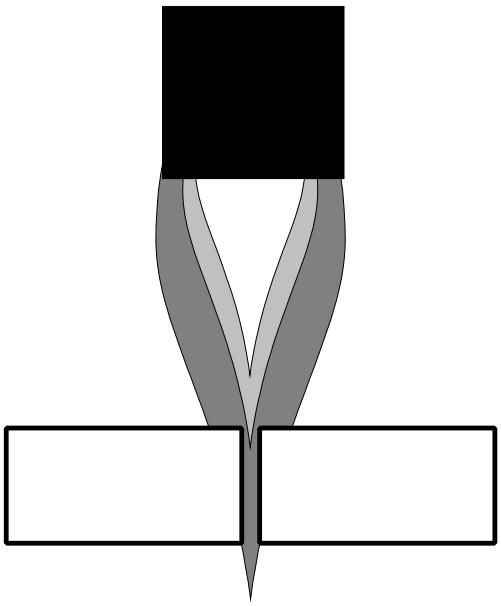
- Oxy-Acetylene
  - 48 kJ/L
  - Efficiency = 25%-50% or 50%-80%
- Shielded Metal Arc Welding
  - $5x10^6$ - $5x10^8$ W/m^2
  - Efficiency = 65%-85%

Notice
The time required to form the joint through flame welding is 10x that of arc welding

Ref: Messler R.W.: Principles of Welding;Wiley (1999)

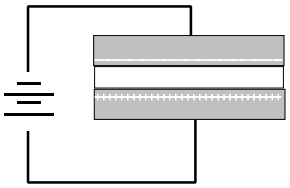
Oxy-Fuel Welding

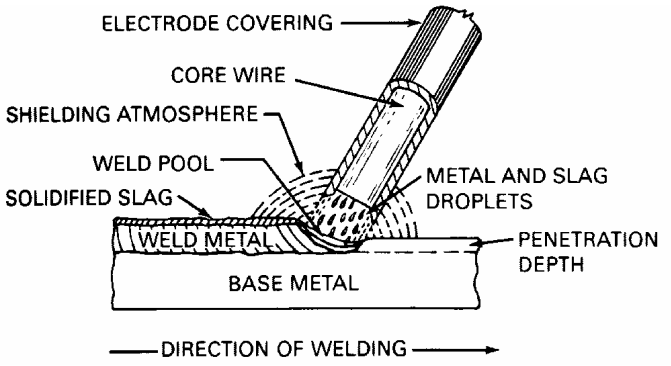
- Heat Supplied by Combustion of Acetylene (C_2H_2)
- Control of Flame
  - Oxidizing
  - Neutral
  - Reducing



Shielded Metal Arc Welding

- Power Source
  - Electric Arc (Lightning)

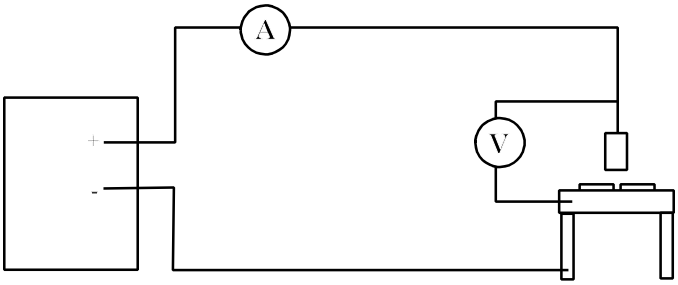




Ref: D.Dickinson: Course Notes and NEMJet

Typical Set Up

- Huge Voltage
- Safety



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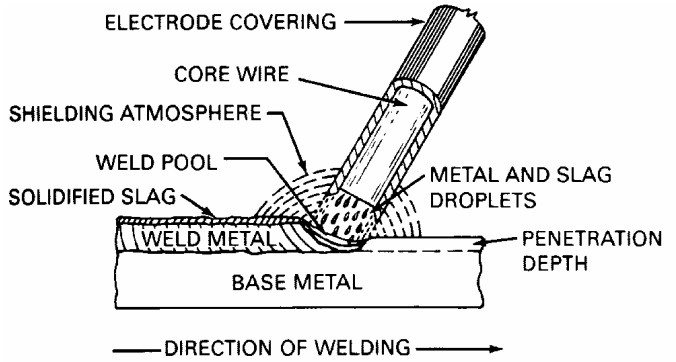
SMAW More Details

- A Flux Coats the Electrode
  - During Welding Heat is Generated
  - Flux Evaporates
  - Removes $O_2(g)$



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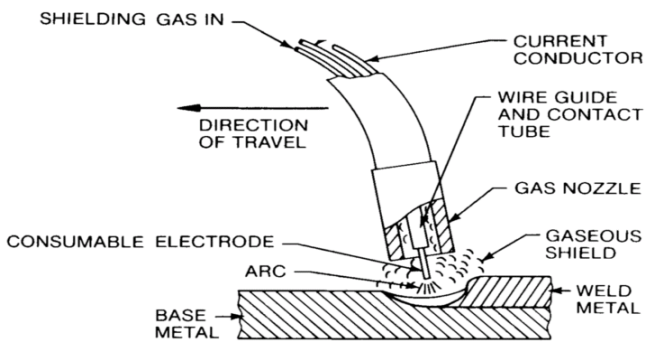
SMAW Advantages

- Easily Implemented
- Inexpensive
- Flexible
- Compared to Flame Sources
  - Cost ?
  - Easier Protection of Weld Pool
  - Faster

GMAW or MIG

- Power Source
  - Electric Arc
  - Like SMAW
- Protection
  - Inert Gas From Feed



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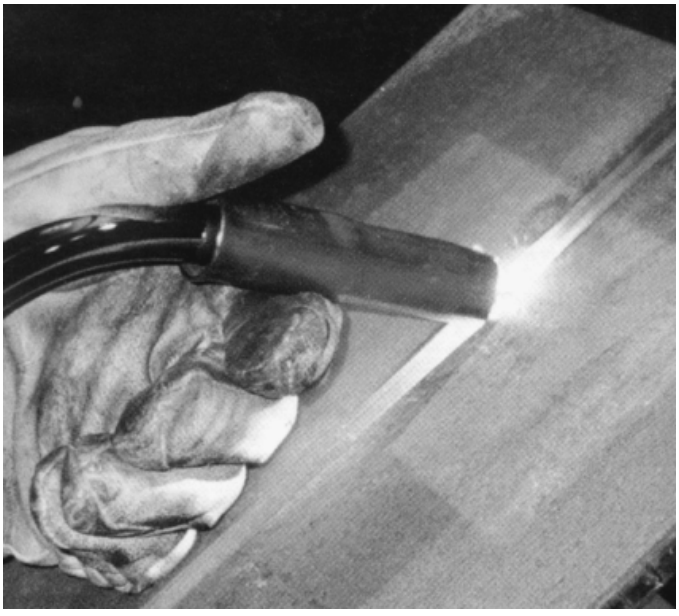
MIG Gun

- Bulkier than SMAW Stick Holder
- Requires
  - Gas Souce
  - Metal Wire Feed
  -



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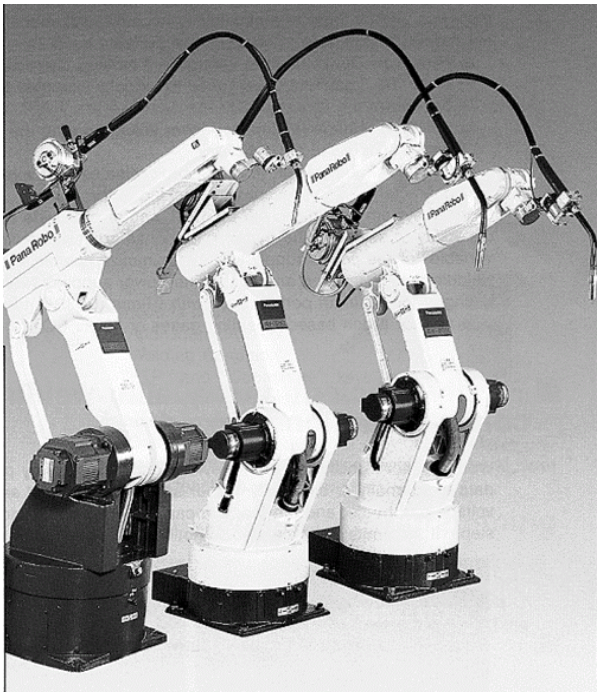
Robots and Automation

- MIG Welding is Automatabile
  - Wire Feed
  - Gas Flow Rate
  - Position
- Difficult Manual Operation



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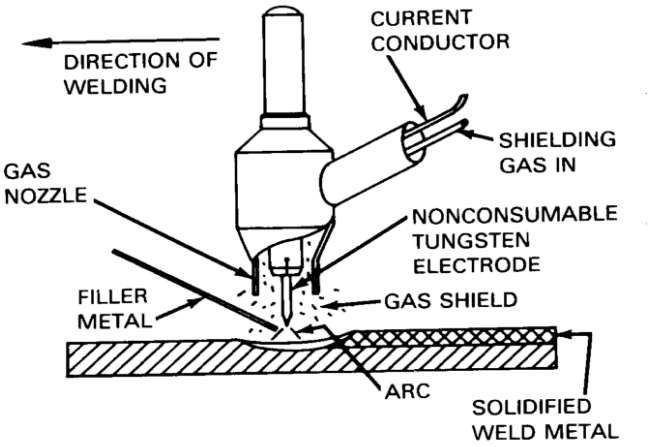
GTAW

- Heat Source
  - Arc From Tungsten (W) Electrode
- Protection
  - Inert Gas from Feed
- Alloying
  - Filler Rod can Be Used



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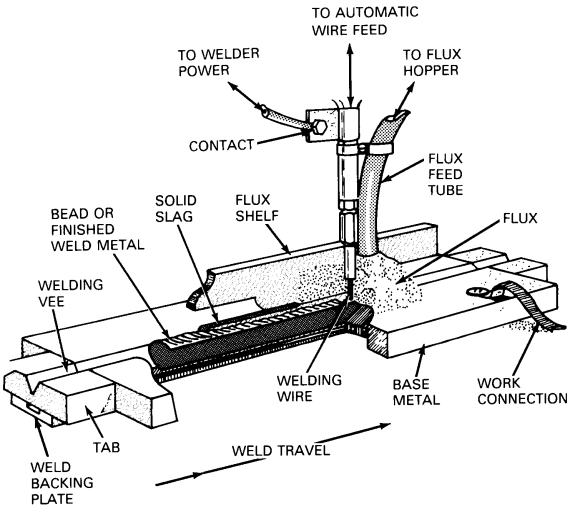
TIG Gun

- TIG Gun
  - Complicated
- Filler Metal
  - On the Side
- Requires
  - Gas Source
  - Wire Feed
  - Tip Maintenance

Ref: D.Dickinson: Course Notes and NEMJet

Spot Welding

- The Arc is Submerged in Powder



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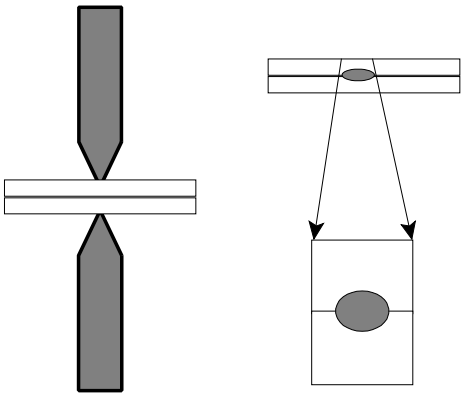
Spot Welding

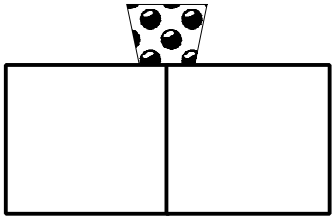
- Electric Resistance Welding
  - Electrical Contact Under Pressure
  - Localized

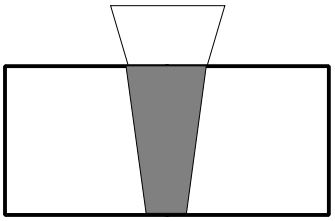
$$E = I^2 Rt$$



Thermit Welding

- Use of Chemical Reaction
  - $Al(s) + Fe_2O_3(s) \rightarrow Fe(l) + Al_2O_3(s)$





Friction Welding

- Use Friction to Generate Heat
  - High Speed Part
  - Causes Joint to Form