Tools & Equipments, Mechanical Skills

Solder

Thread

Marking

Material

Equip-ments

Electric

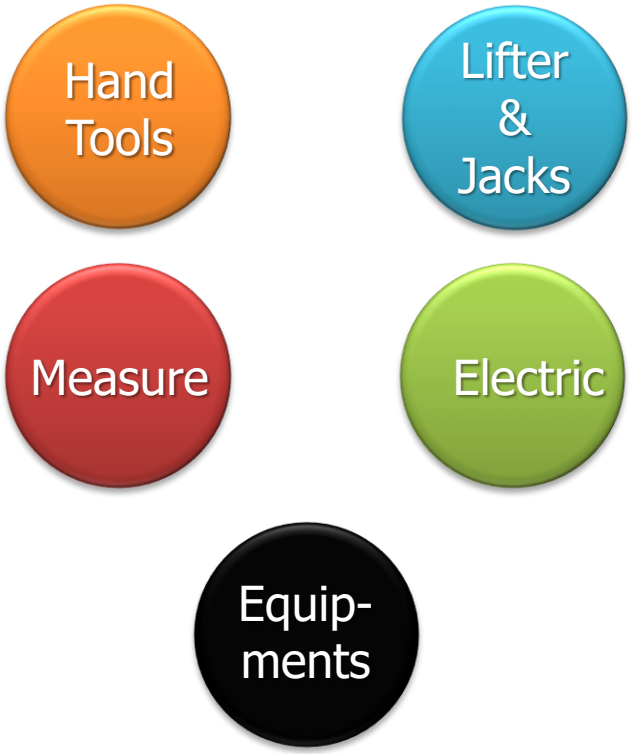
Measure

Lifter & Jacks

Hand Tools

Tools & Equipments, Mechanical Skills

Part 1



Tools and Equipments

TOOL BOX

Tools and Equipments

Hand Tools :

WRENCH

Open End Wrench

Flare Nut Wrench

Combination Wrench

Adjustable Wrench

Double Offset Wrench

Tools and Equipments

Hand Tools :

WRENCH

Half Moon Wrench

Allen key Wrench

Allen Torx Wrench

Tools and Equipments

Hand Tools :

PLIERS

Retaining Ring Pliers

Needle Nose Pliers

Cutter

Needle Nose Pliers

Combination Pliers

Tools and Equipments

Hand Tools :

PLIERS

Multi - Grip pliers

Ring Compressor pliers

Wire Stripper

wire-stripping-pliers

Vise grip

Tools and Equipments

Hand Tools :

PLIERS

Chain Wrench

Brake Spring Pliers

Oil Filter Pliers

Valve Seal Pliers

Tools and Equipments

Hand Tools :

HAMMERS

Piston Hammer

Plastic Hammer

Brass Hammer

Bronze Hammer

Rubber Hammer

Ball Peen Hammer

Tools and Equipments

Hand Tools :

SOCKETS

Sliding T-Handle

Socket

Universal Joint

Speeder

Extension

Tools and Equipments

Hand Tools :

SOCKETS

Driver TORX Socket

Ratchet

Oxygen Sensor Socket

Spark Plug Socket

Breaker Bar

Tools and Equipments

Hand Tools :

SOCKETS

Adaptor

Wheel Spanner

Oil Filter Cup

Tools and Equipments

Hand Tools :

SCREWDRIVERS

Flat Screwdriver

Phillips Screwdriver

Flat Tip Screwdriver
(Stubby)

Phillips Tip Screwdriver
(Stubby)

Tools and Equipments

Hand Tools :

Seat Cover

Scraper

Ring Compressor

Fender Cover

Tools and Equipments

Hand Tools :

Oiler

Valve Spring Compressor

Wire Brush

Pick Up Magnetic

Tools and Equipments

Hand Tools :

Piston Ring Groove Cleaner

Piston Ring Expander

Blow Gun

Tension Pulley Spanner

Tools and Equipments

LIFTERS

Two Post Lifts

Four Post Lifts

Tools and Equipments

LIFTERS

Transmission Jack

Engine Lift Hoist

Tools and Equipments

JACKS

Hydraulic Floor Jack

Tire Choke

Hydraulic Bottle Jack

Tools and Equipments

STANDS

Floor Jack Stand

Utility Stand

Stand Fuel Tank

Tools and Equipments

MEASUREMENTS TOOLS

Digital Micrometer

Feeler Gauge

Vernier Caliper

Straight Edge

Digital Vernier Caliper

Tools and Equipments

MEASUREMENTS TOOLS

Depth Micrometer

Outside Micrometer

Dial Indicator

Telescoping Gauge

Magnetic Holder

Tools and Equipments

MEASUREMENTS TOOLS

Ridge Reamer

Cylinder Bore Gauge

Brake Pressure Test ABS

Micrometer Brake Drum

Tools and Equipments

MEASUREMENTS TOOLS

Leak Detector

Torque Wrench

Gauge Manifold Test R134a

Cooling System Tester

Tools and Equipments

MEASUREMENTS TOOLS

Tire Pressure Gauge

Torque Angle Gauge

Tension Belt Gauge

Tire Air Pressure

Tools and Equipments

ELECTRIC

Terminal Cleaner

Pullers Cable Clamp

Fuse Tool

Hydrometer Battery

Battery Carrier

Tools and Equipments

ELECTRIC

Cable Clamp Pliers

Booster Cable

Battery Service

Utility Light

Thermometer

Tools and Equipments

ELECTRIC

Infrared Thermometer

Soldering Gun

Tester Lamp

Solder

Injector Harness Tester

Tools and Equipments

ELECTRIC

Multimeter

Tester, Diagnostic, Battery /Charging/Starting System, Electronic

OBD II Breakout

Scan Tools

Leak Detection R134a

Tools and Equipments

ELECTRIC

Charger Battery

Digital Timing Light

A/C Service Machine R134a

Tools and Equipments

EQUIPMENTS

Brake Bleeder

Waste Oil Collector

Power Grease Gun

Creeper

Tools and Equipments

EQUIPMENTS

Tire Changer

Wheel Balancer

Tools and Equipments

EQUIPMENTS

Vacuum Filler
Cooling System

Clutch Aligner

Automatic Transmission
Pressure Gauge

Tools and Equipments

EQUIPMENTS

Compression Gauge

Cooling System Tester

Oil Pressure Gauge

Tools and Equipments

EQUIPMENTS

Cylinder Leakage Tester

Puller Power Steering Pump

Fuel Injection Pressure Gauge

Tools and Equipments

EQUIPMENTS

Vacuum Pump

Orifice Tube Service

Steering Wheel Puller

Tools and Equipments

EQUIPMENTS

Hand Held Gas Analyzer

Puller, Interchangeable, Heavy Duty, Manual/Hydraulic (with tool board)

Tools and Equipments

EQUIPMENTS

Air Compressor

Lathe, Brake, Bench with Basic Adaptor Set

Tools and Equipments

EQUIPMENTS

Master Spring Compressor

Fuel Service System

Tools and Equipments

EQUIPMENTS

Valve Lapper Holder

Separator Ball Joint

Hood Prop

Grease Gun

Tools and Equipments

EQUIPMENTS

Standard TDC Indicator

Sound Noise Mechanic

Vacuum Pump R134a

Impact Air Wrench

Tools and Equipments

EQUIPMENTS

Hydraulic Floor Press

Brake Testers

Tools and Equipments

EQUIPMENTS

Wheel Alignment Machine

Quiz 1

Tools & Equipments, Mechanical Skills

Part 2

METAL AND THEIR PROPERTIES

1.1 Classification of Metals;

* **Cast Iron**	* **Aluminum**
* Wrought Iron	* Copper
* Steel	* Lead
- Low-Carbon Steel	* Nickel
- Medium-Carbon Steel	* Tin
- High-Carbon Steel	* Zink
- Alloy Steel	Nonferrous Alloys
- High-Speed Steel	* Brass (Copper-Zink Alloy)
	* Bronze (Copper-Tin Alloy)

MELTING POINT

The melting point is the temperature at which a material starts to melt.

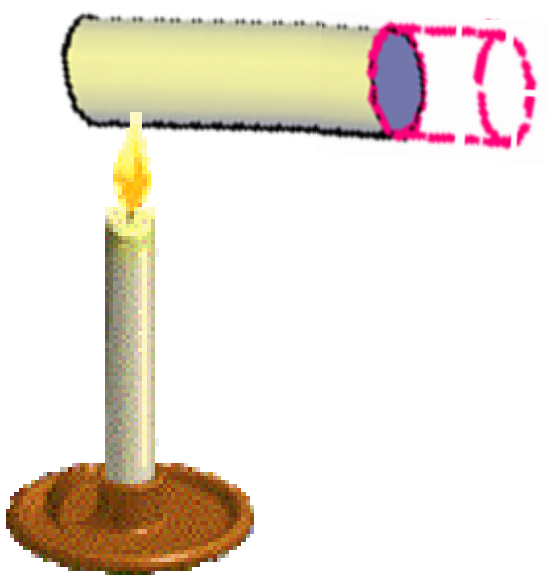
Ferrous	**1,536 degree Celsius**
Copper	1,083 degree Celsius
Lead	327 degree Celsius
Aluminum	658 degree Celsius
Tin	232 degree Celsius
Tungsten	3,387 degree Celsius

ELECTRICAL CONDUCTIVITY

The electrical conductivity describes the ability of a material to conduct electricity.

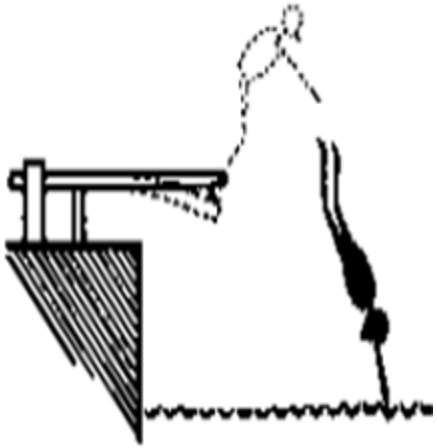
Copper	**100 %**
Silver	106 %
Lead	8 %
Aluminum	62 %
Ferrous	17 %
Zinc	29 %

THERMAL LONGITUDINAL EXPANSION



To express the thermal longitudinal expansion, there is a coefficient that gives for each material the expansion of a body with the length of 1 Meter at a change of temperature of 1 degree Celsius.

MECHANICAL PROPERTIES



Elasticity:

Is the ability of a metal to return to its original shape after being distorted. Properly heat–treated springs are good examples of elastic materials.

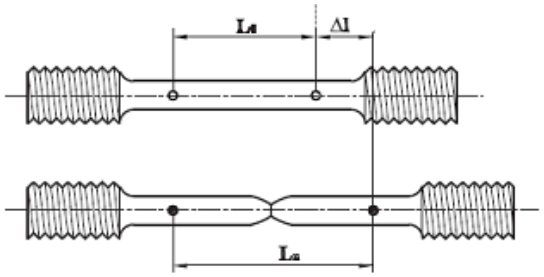
Spring

Ductility:

Is the ability of a metal to be permanently deformed without breaking. Metals such as copper and machine steel, which may be drawn into wire, are ductile materials.

Wire

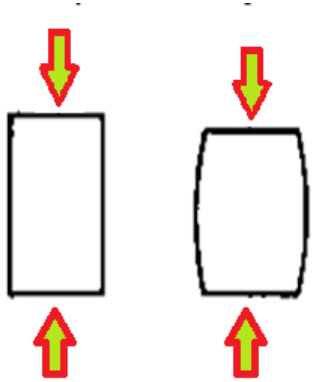
MECHANICAL PROPERTIES



Tensile Strength:

The ability of material to resist fracture under tensile load.

bolt



Compressive Strength:

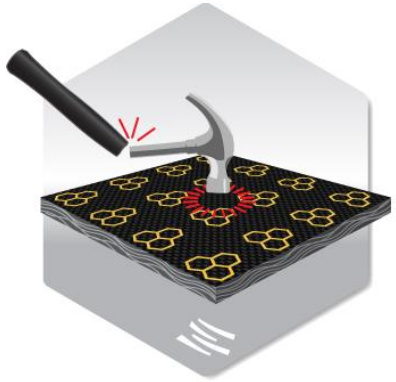
The ability of a material to withstand heavy compressive load.

MECHANICAL PROPERTIES

Brittleness:

Is the property of a metal that allows no permanent distortion before breaking.

Gear Teeth



Toughness:

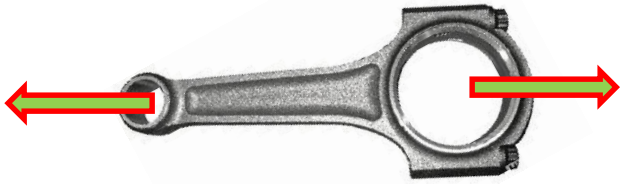
Is the ability of metals to withstand shock or impact. Toughness is the opposite of brittleness.

Timing Chain

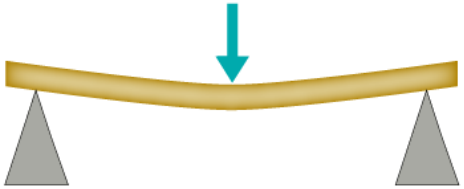
MECHANICAL PROPERTIES

Shear Strength:

The ability of a material to resist fracture under shear load.



Connecting Rod

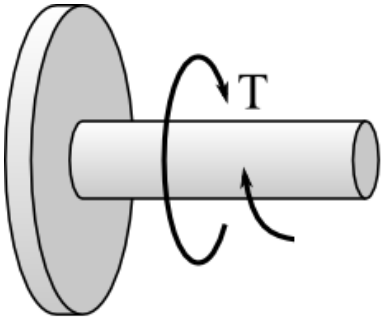


Flexural Strength:

The ability of a metal to resist under flexural force.

Metal Plate

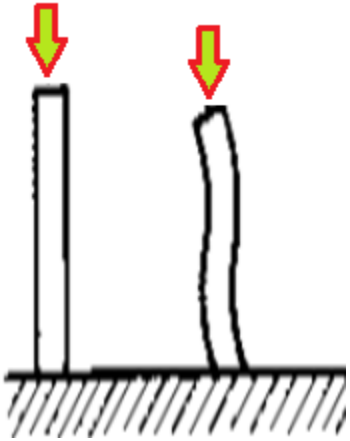
MECHANICAL PROPERTIES



Torsional Strength:

The ability of a metal to resist torsional force.

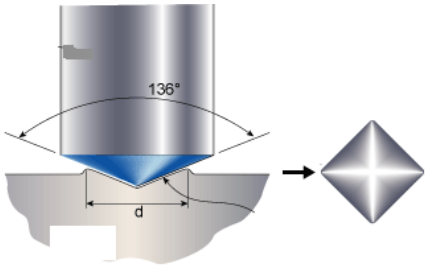
Axel Car



Collapsing Stress:

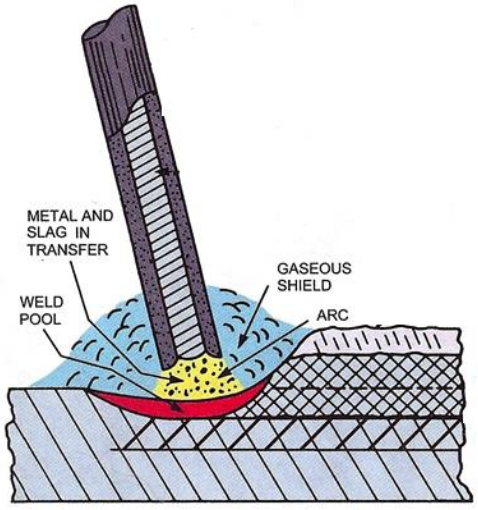
The ability of a metal with a slim form to resist axial directed force.

MANUFACTURING PROPERTIES



Hardness:

The ability of metal to withstand abrasion or penetration.



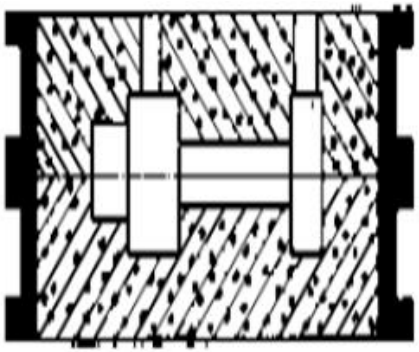
Weld ability:

Means the ability to weld two metals together. The grade of weld ability depends on the content of carbon, Steels with a content of max. 0.22% are more or less good weldable.

MANUFACTURING PROPERTIES

Machine ability:

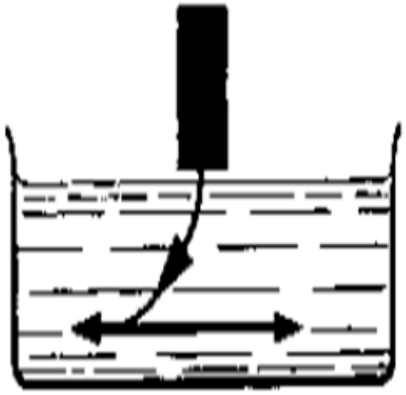
Indicates how easy or difficult materials can be machined.



Cast ability:

Is the property of metals that allows it to be molten and after it to be casted without any pores.

CHEMICALPROPERTIES



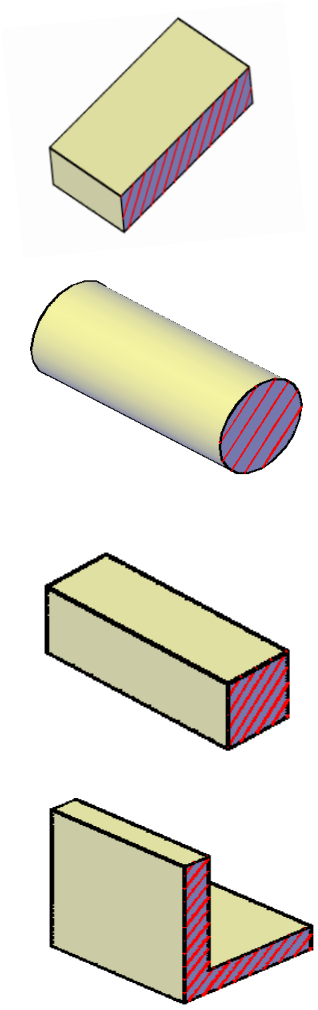
Harden ability:

Is the property of iron metals that allows it to increase the hardening through structural transformations.

Corrosion Resistance:

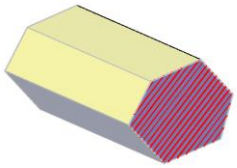
Is the ability of a material to resist the attack of water, gases, acids or other chemicals.

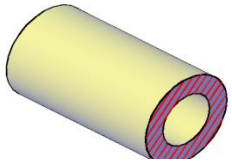
SHAPES AND SIZE OF METAL

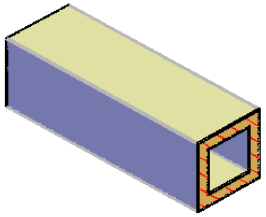


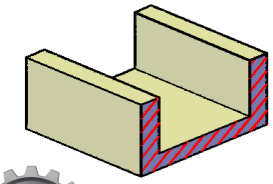
Flat - bar	Thickness x Width x Length
Round - bar	Diameter x Length
Square - bar	Width x Length
Angle - bar	Thickness x Width x Length

SHAPES AND SIZE OF METAL









Hexagon - bar	Diameter x Length (or Distance Across Flats x Length
Pipe - bar	Diameter x Schedule x Length # 20 is thinner than #40
Square - tubing	Thickness x Width x Length
Channel - bar	Width x Height x Length

Marking Out/Lay-out

Accurate marking out and measuring are essential to good metal work.

Many metalwork tasks consist of a number of

different components.

Without accurate marking out at an early stage, the parts would not fit.

It is an important skill to learn.

Marking Out/Lay-out

The STEEL RULE is made of steel and comes in a variety of lengths, it has a zero end and has imperial and metric measurements on it.

The ENGINEER'S TRY SQUARE is accurately set at 90° and is used for marking out and testing right angles.

Marking Out/ Lay-out

The SCRIBER is the metalworker's pencil.

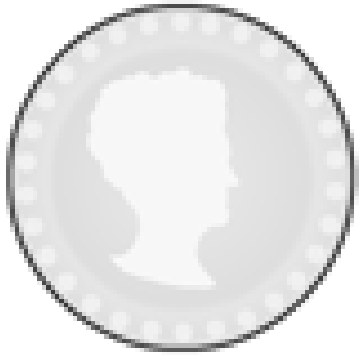
It is a hard, metal point which scratches a fine line onto metal.

The CENTRE PUNCH is used for marking the positions of drilled holes.

The indent created prevents the tip of the drill from wandering.

Marking Out/ Lay-out

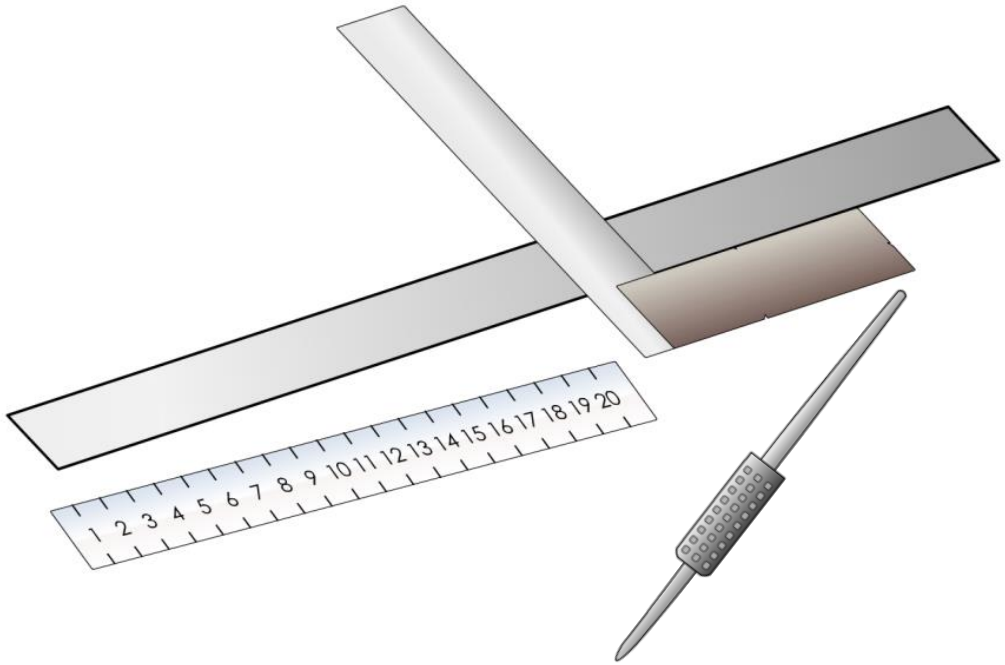
A COIN is needed to create a RADIUS on the edge of the steel to improve the appearance and make it safe, with no sharp edges.



Marking Out/ Lay-out

From making a model you will realise the length and number of pieces of mild steel you will need to make your design.

Using a STEEL RULE, measure the correct length of steel you will need.

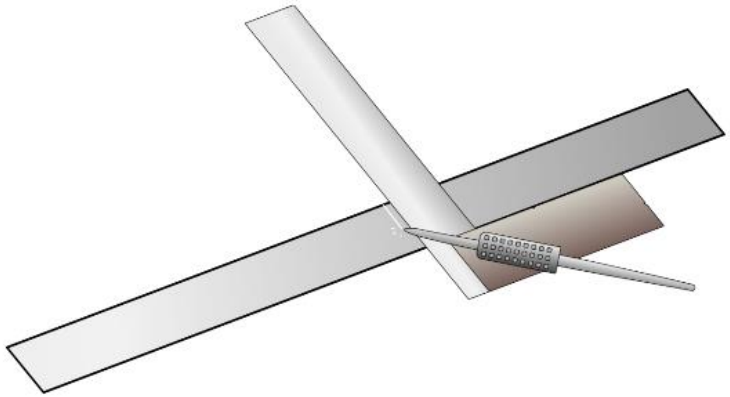


Marking Out/ Lay-out

Line up the ENGINEER'S TRY SQAURE to the edge of the steel.

Using a SCRIBER, scratch a straight line into the steel, at the correct length.

This will identify where to cut the steel later.



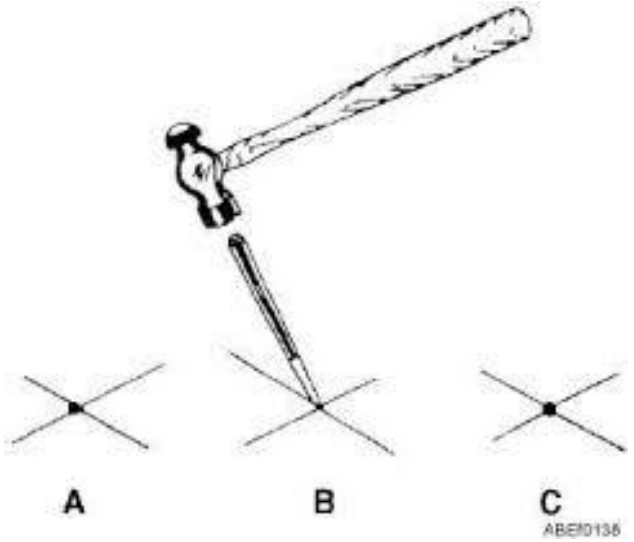
Center Punch :

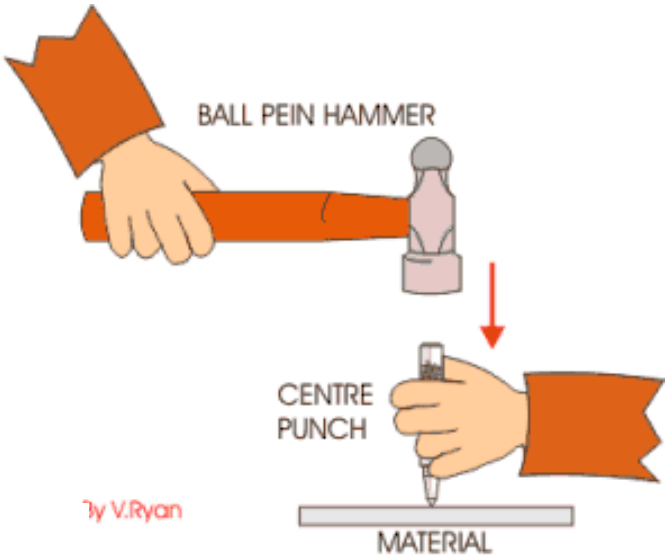
1. Make that the point of the punch is sharp before starting.

2. Hold the punch at a 45 degree angle and place the point carefully on the layout line.

3. Tilt the punch to a vertical position and strike it gently with a light hammer.

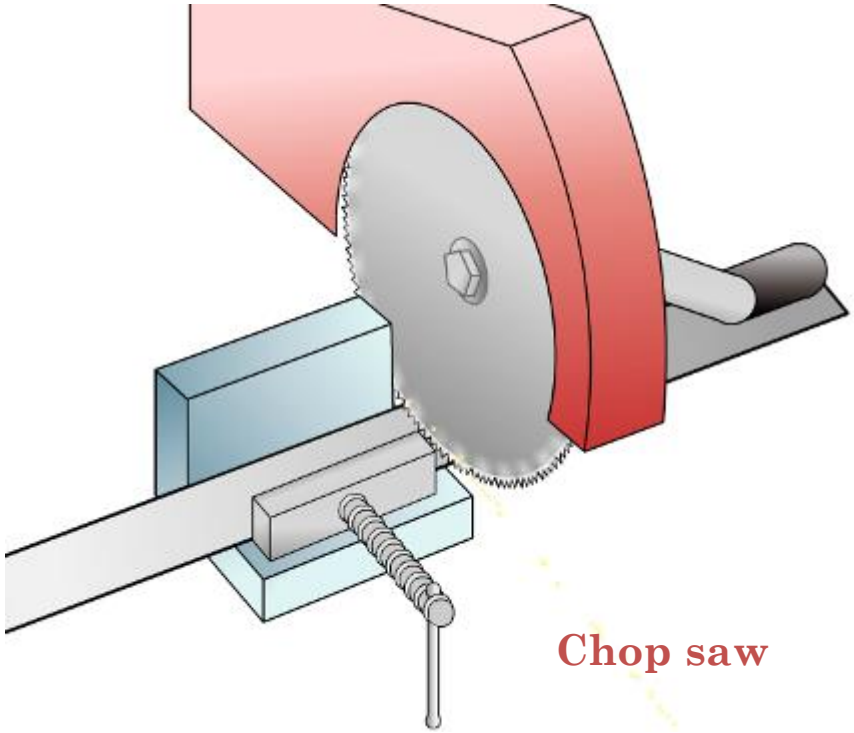
4. If the punch mark is not in the proper position, correct it as necessary.





Cutting and shaping

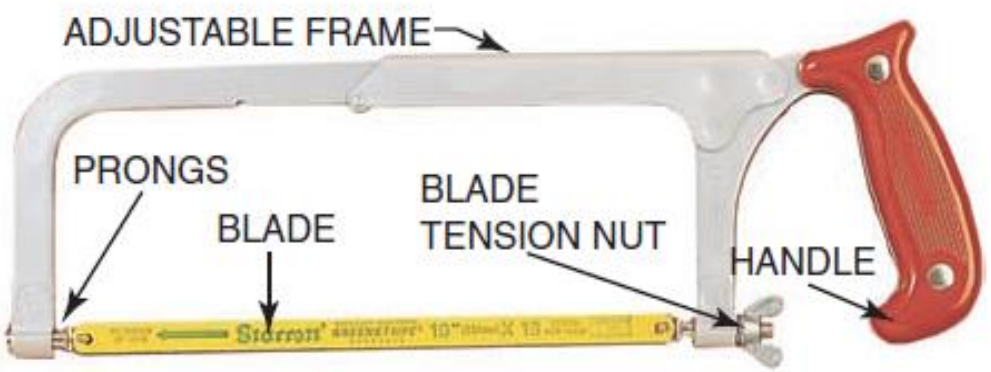
The mild steel can be cut in two different ways depending on what equipment you have in the workshop.



Chop saw

Cutting and shaping

You could cut the steel by hand using an ADJUSTABLE HACKSAW or by machine, using a CHOP SAW.



Hacksaws are made to cut metal

1. Be sure safety glasses are worn.

2. Select a blade with enough teeth per inch so that two or three teeth are in contact with the metal at all times.
   - There must be few enough teeth to the inch to allow the gullets to carry off the chips without clogging.

3. Fasten the blade into the hacksaw frame with the teeth pointing away from the handle of the saw.
   - Make sure the blade is fastened securely so that it will not twist and break.

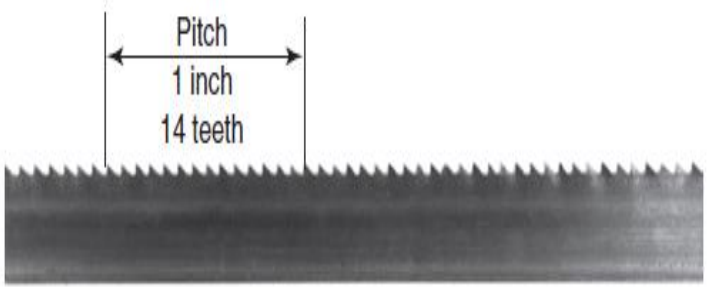
Installing a Hacksaw Blade

First, make certain teeth are pointing away from handle, and place holes in blade over both pins.

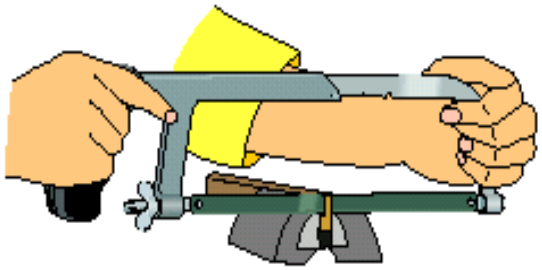
Then, tension blade.

Hacksaws

4. Mark the stock at the point at which it is to be cut.
5. Place the stock in the vise, with the mark about ½ inch from the jaws.

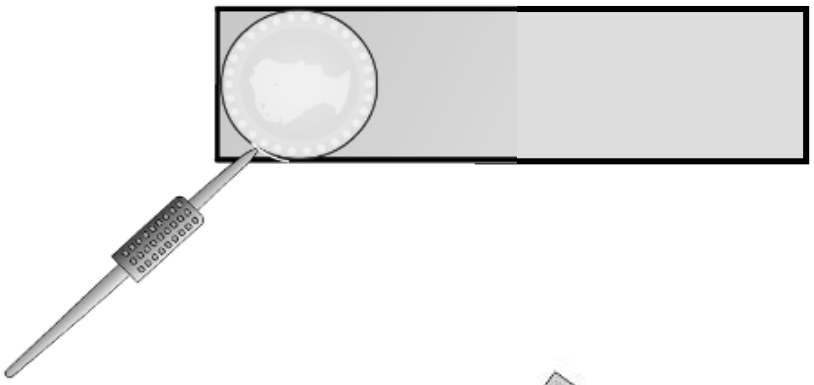


6. Place the saw on the mark and then pull it toward you using little pressure to start the kerf.
   - To help get the saw started in the proper place, a notch can be cut at the mark with a file.

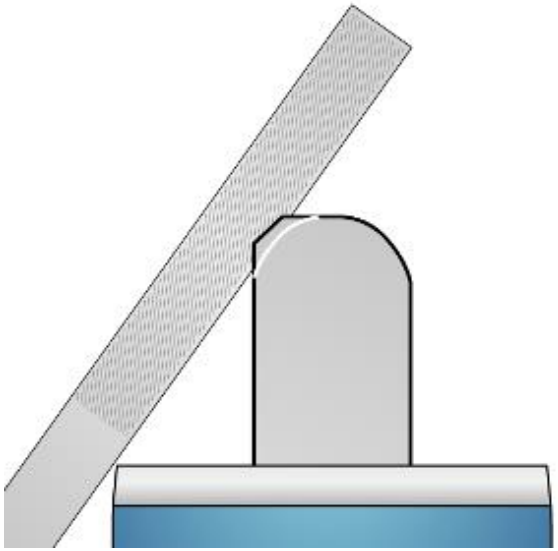


Filing and Shaping

1. On both ends of your piece of steel, draw around a coin with a scriber, to create a radius.

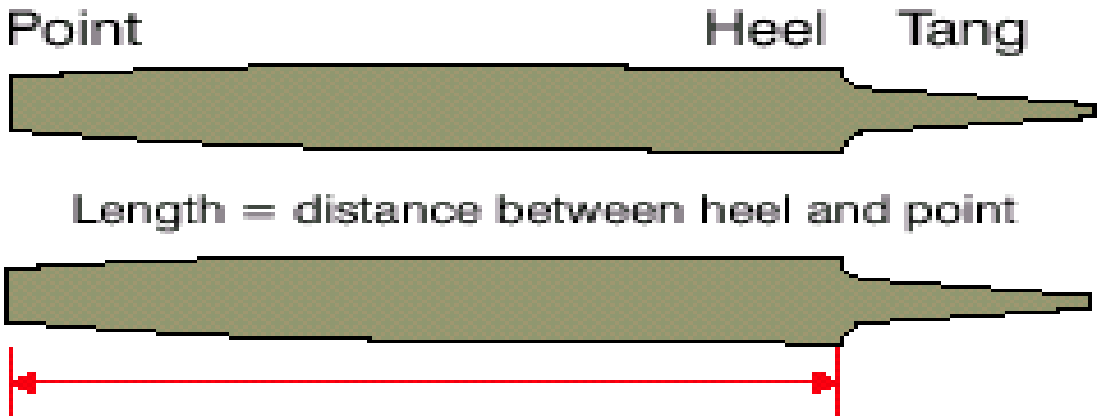


2. Using an appropriate FILE, file until you create a smooth radius on each end of your steel. Be careful of the metal bur – file it off.



Files

- Files come in various shapes and sizes and in various sizes of cuts (chisel teeth).
  - A file with straight teeth all going in the same direction is a single cut file.
  - A file with teeth in two directions is known as a double cut file.



Cuts of a File

Single-cut

Second-cut

Smooth

Bastard

Doubl-cut

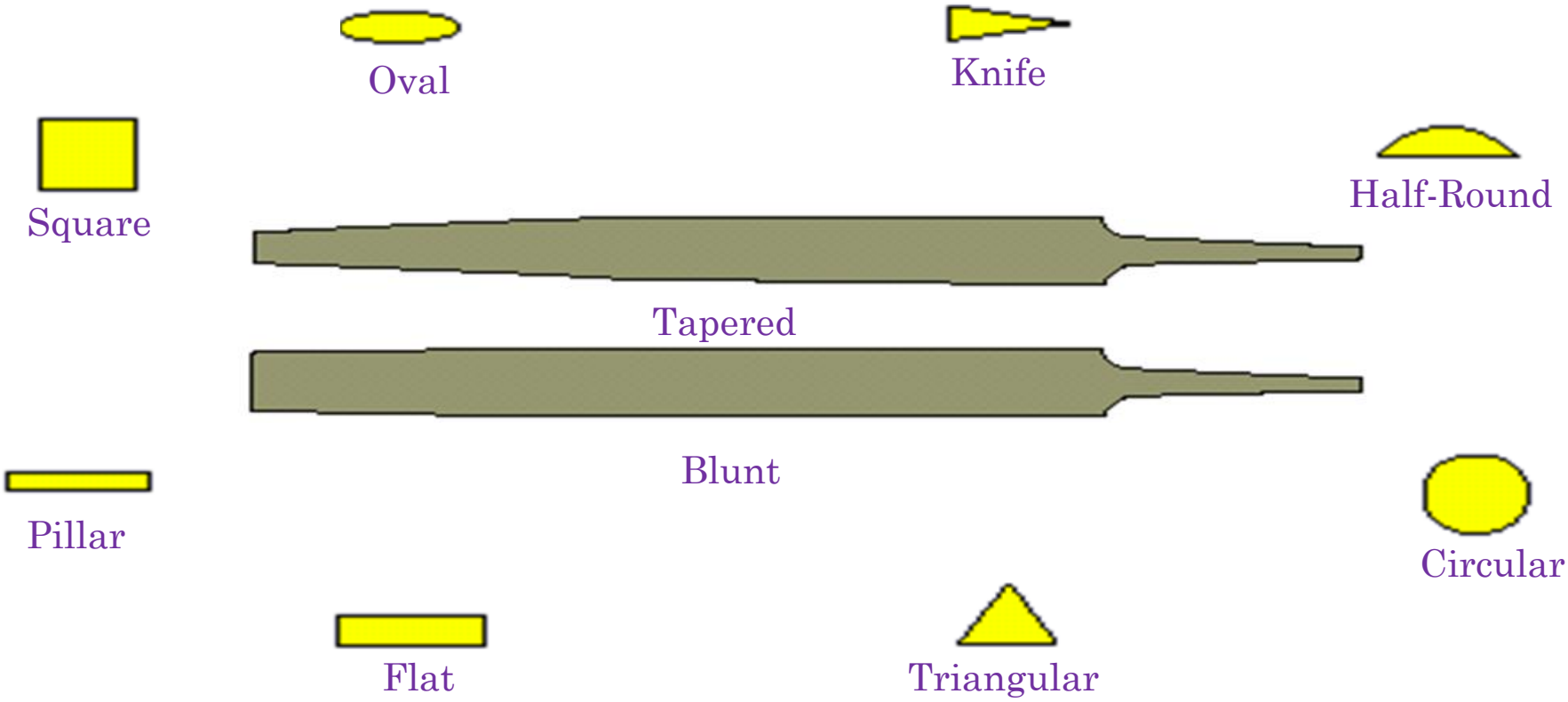
Second-cut

Smooth

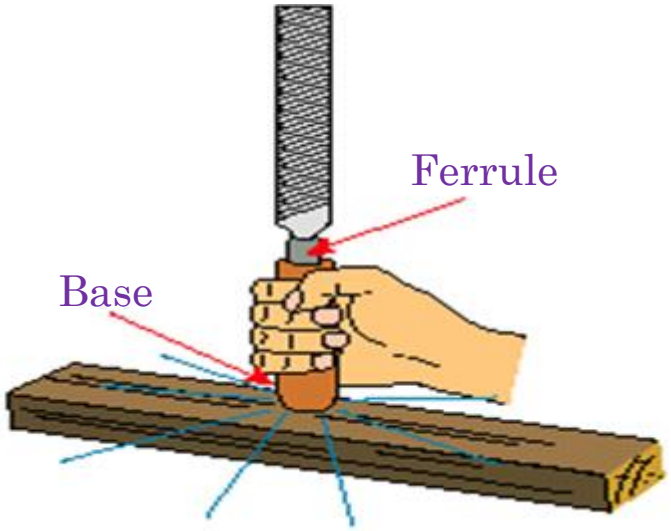
Bastard

Cuts of a File

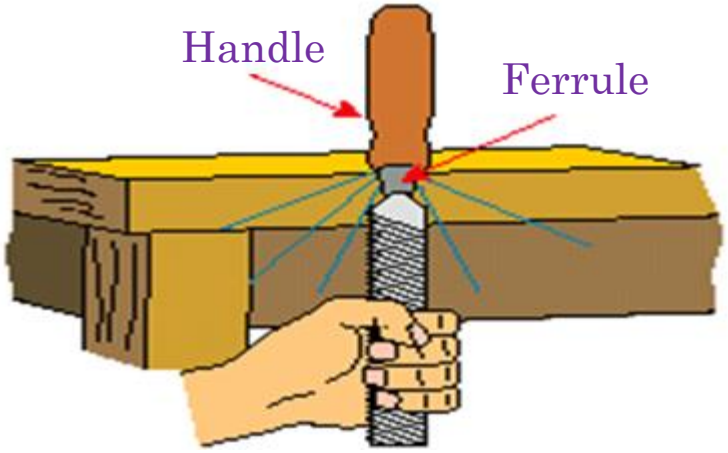
Shapes of a File



Care of a File



Setting a file handle



Removing a file handle

Clean file with file card

Files

Small amounts of metal may be removed where needed with a file:

1. Be sure safety glasses are worn.

2. Mark the material to be filed.

3. Place the stock in a vise or clamp it to the table.

4. Select the correct file for the job to be done.

5. File teeth usually slant toward the point of the file and therefore cut only on the forward stroke.

Files

6. A handle should be placed on the tang of the file.

7. Hold the handle of the file against the palm of the hand, with the thumb on the top of the handle.

8. Hold the point of the file with the thumb and index finger of the other hand.

9. Use pressure on the forward stroke only, and use only enough pressure to make the file cut evenly.

Proper filing positions

Hold Handle in Right Hand and Tip with Left

Holding a File Properly

Draw Filing

Files

10. Lift the file on the return stroke.

11. Do not take more than 30 to 40 strokes a minute.
    - Excessive speeds will ruin both the file and the work.
12. Rubbing chalk on a file before it is used will help to prevent it from becoming clogged.
    - If a file becomes clogged, it may be cleaned with a file card, pick, and brush.

Files

13. Do not use a file on material harder than the file.

14. Store files in separate holders
    to prevent their rubbing together
    or knocking against other tools.
    – The teeth are brittle and thus
      are easily dulled or broken.

Drill Press

- The drill press is the preferred tool for making holes in materials.

Drill Press

1- On/Off Switch

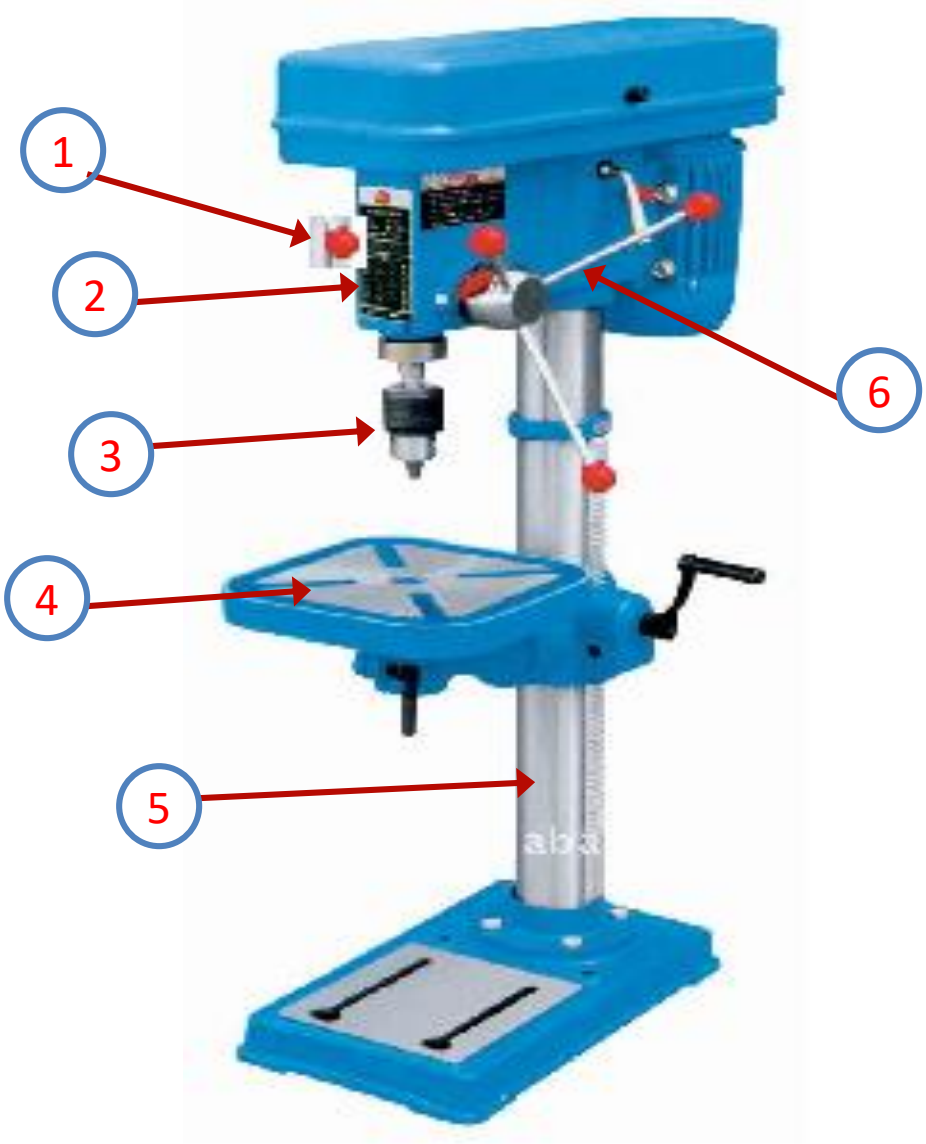
2- Depth Stop

3- Chuck

4- Table

5- Column

6- Feed Handle



Alternatives to the Drill Press

- There are many ways to drill holes in material
  - You could use a electric plug-in or cordless hand drills.

Drill Press Uses

- The drill press can be used for a variety of applications.
  - It may be used to drill through metals, woods and plastics.

Metal

Plastics

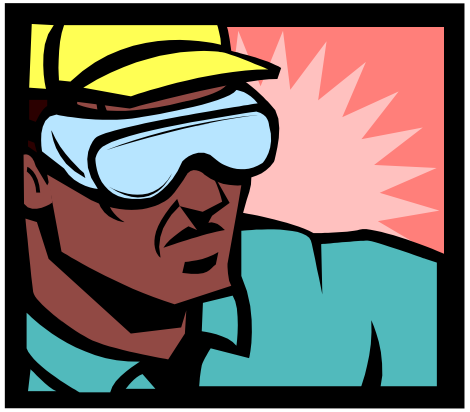
Wood

Drill Bits for the Drill Press

- You may use a variety of drill bits on the drill press.

Drill Press Safety

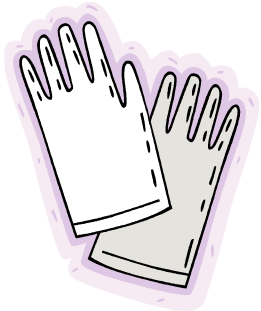
- Wear eye protection at all times.



- Do not operate the drill press until you have passed all safety requirements.

Drill Press Safety

- Always make sure that small stock is securely clamped in a drill press vise.
- Do not try to hold small pieces of stock by hand.
- Place the long end of the piece being drilled to the left side. This is so it will hit the post and not the operator, should the material slip and start rotating.
- Always remove the chuck key immediately after installing a bit. Place key back in holder
- Never wear gloves when operating the drill press. They may get caught.



Drill Press Safety

- Do not wear your hair long, or wear long sleeves or dangling strings or jewelry. Tuck it in or tie it back!

- Back the bit out frequently on deep cuts, to clean and cool the bit.

Drill Press Safety

- Insert bit into chuck

- Tighten it by hand

Drill Press Safety

- Find the chuck key

- in the key chuck holder

Drill Press Safety

- Tighten with chuck key

- Remember : Righty Tighty

CORRECT DRILLING POSITION

Use correct vise clamp to hold your work piece in drilling.

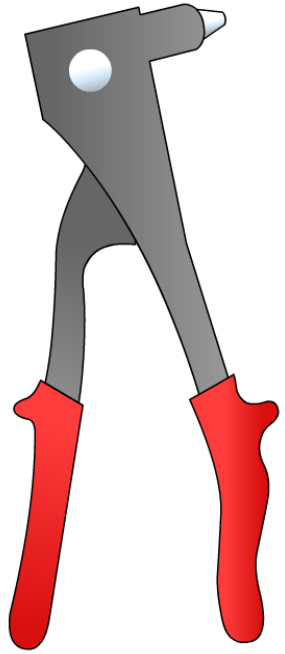
Pop Riveting :

POP RIVETING is quick and easy and can be done from one side of the work.

Rivets are made from soft, malleable metals such as iron, brass and aluminium.

Pop rivets always leave a protruding head.

Pop riveting is a process used to join metals in aircraft construction and ship building.



pop rivet gun

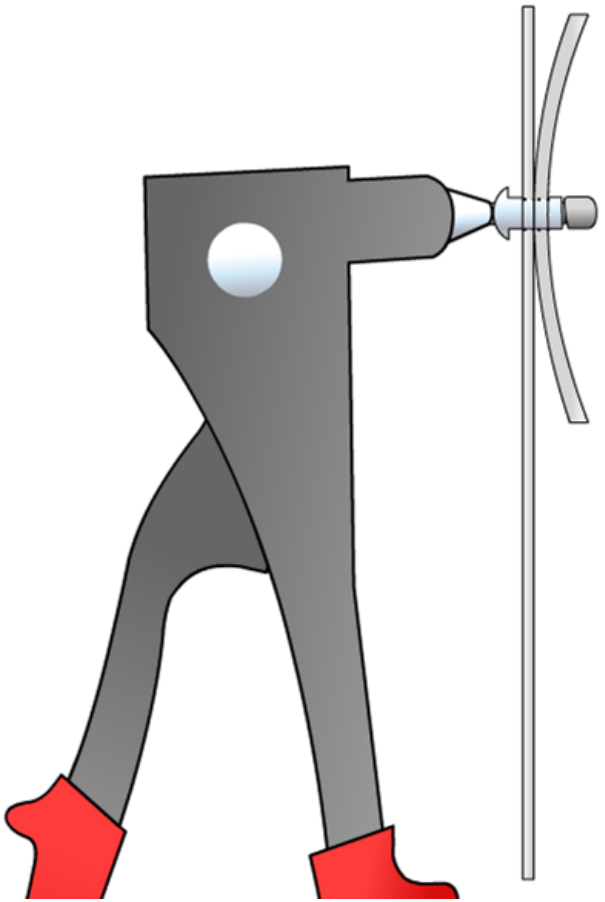
pop rivet

Pop Riveting :

1. Align the pre-drilled holes of the dish and the steel scroll or piece of steel in a vice.

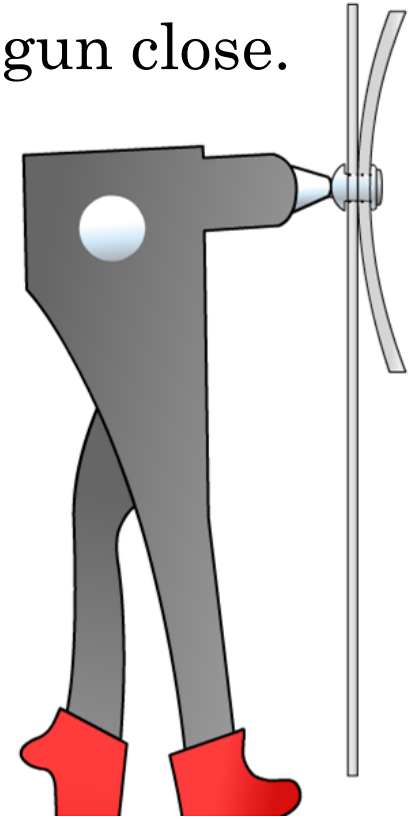
2. Place the central pin of the pop rivet into the open jaws of the pop rivet gun.

   Feed the head of the rivet into the aligned holes of the steel.



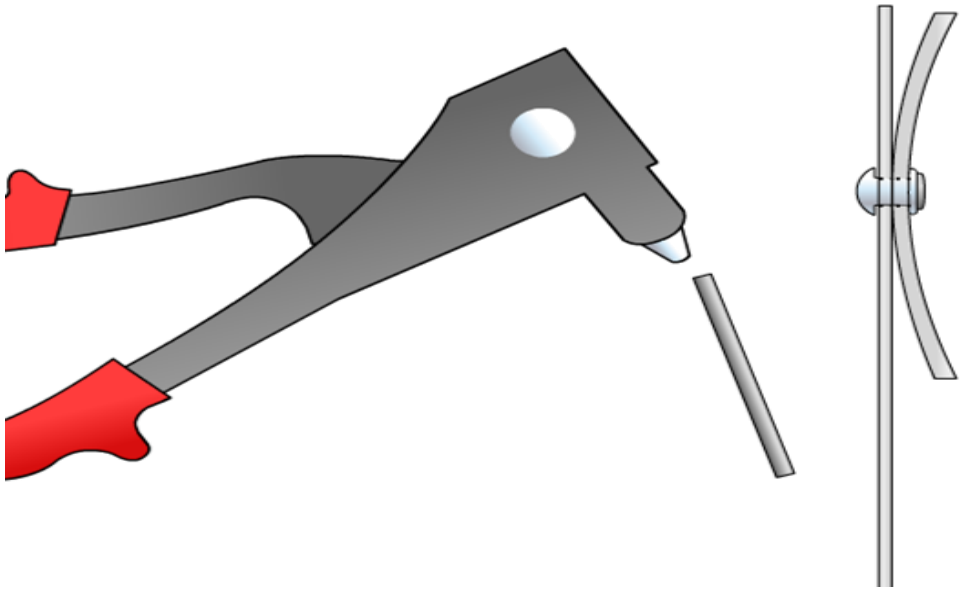
Pop Riveting :

3. Slowly squeeze the jaws of the pop rivet gun close. You will notice the head of the rivet will start to deform and the two pieces of steel are squeezed and joined together.



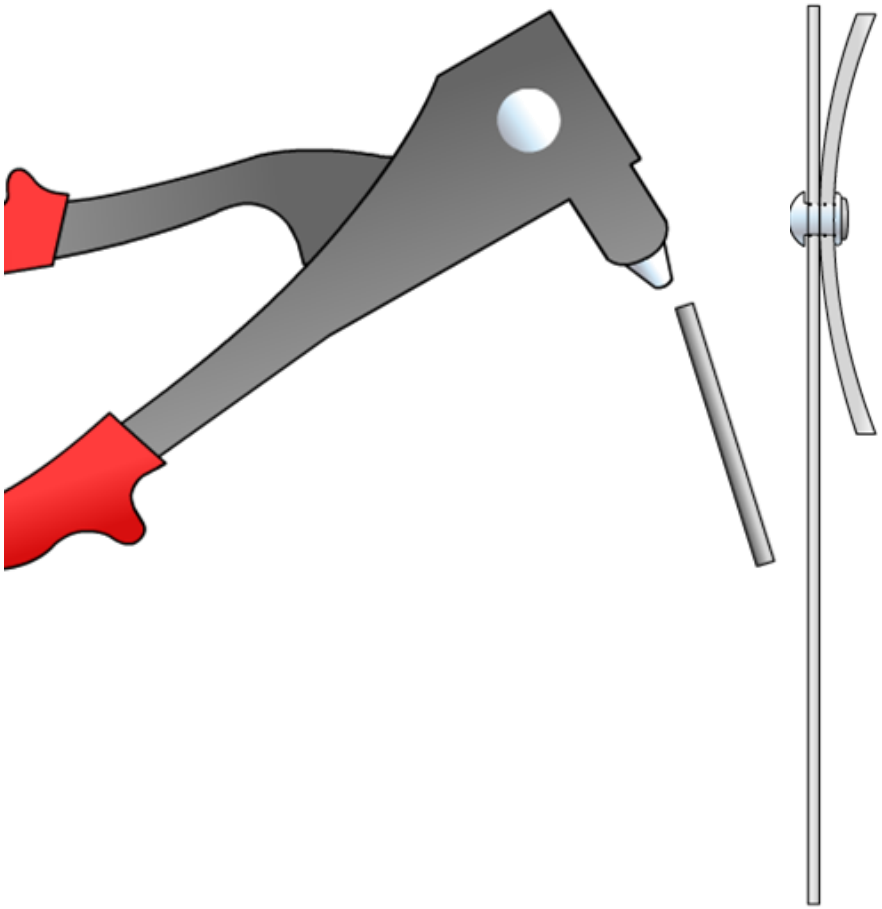
4. When the strain on the central pin becomes so great, it will fracture and a ‘pop’ noise will indicate when the pin breaks away from the rivet head.

Pop Riveting :



5. Open the jaws of the pop rivet gun and allow the pin to fall out. The pop riveted joint is completed.

Recap – can you explain what is happening?



Align the pre-drilled holes of the dish and the steel scroll steel in a vice

Place the central pin of the pop rivet into the open jaws of the pop rivet gun. Feed the rivet into the aligned holes of the steel.

Slowly squeeze the jaws of the pop rivet gun closed.

Open the jaws of the pop rivet gun and allow the pin to fall out.

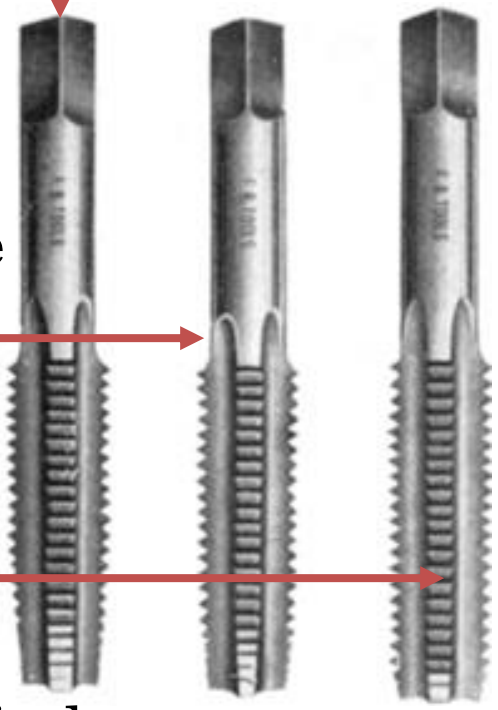
Hand Taps

- Cutting tools used to cut internal threads
- Made from high quality tool steel, hardened and ground
- Two, three, or four flutes cut lengthwise across threads to form cutting edges
  - Provide room for chips
  - Admit cutting fluid to lubricate tap
- End of shank square so tap wrench can be used to turn tap into hole
- Inch tap markings (**½ in.—13 UNC**)
  - Major diameter
  - Number of threads per inch
  - Type of thread

Hand Taps

Sets of Three

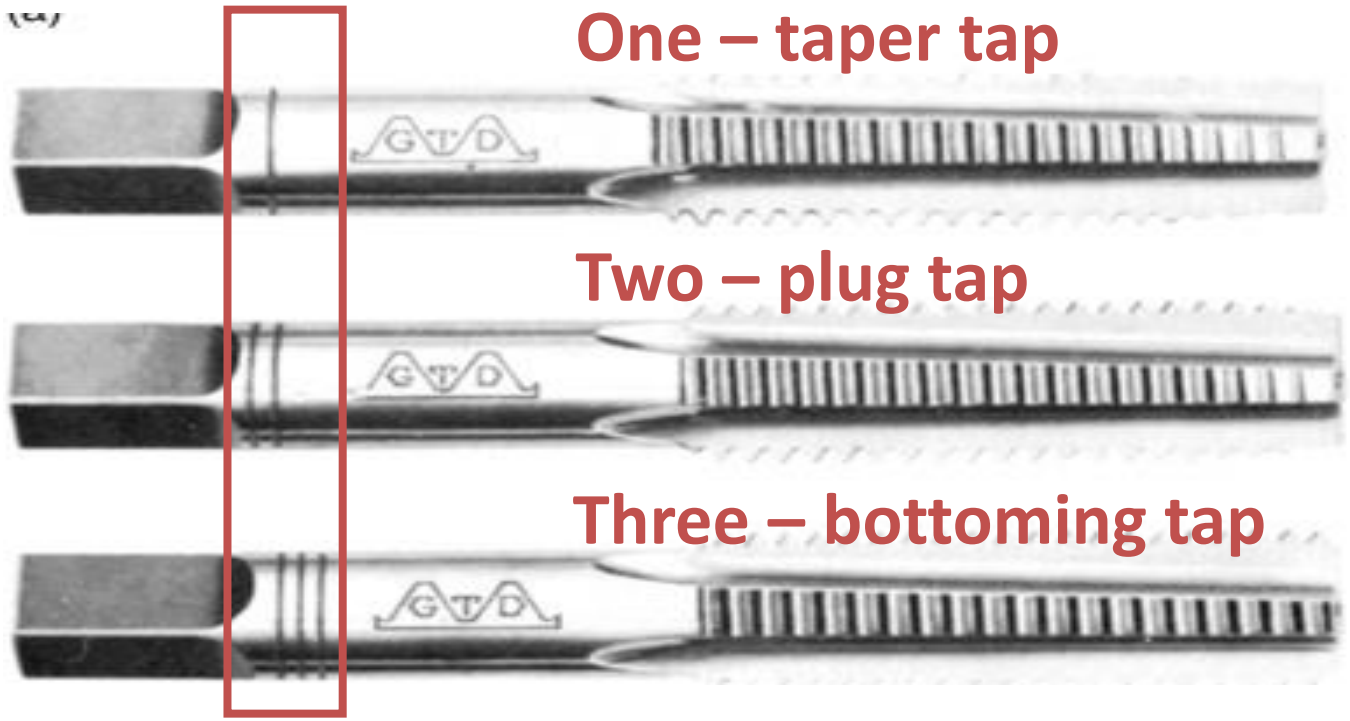
- Taper
  - Tapered from end six threads
  - Used to start thread easily
  - Used for tapping hole that goes through work as well as blind hole
- Plug
  - Tapered for three threads
  - Tread hole through work piece
- Bottoming tap
  - Not tapered but chamfered at end
  - Used for threading to bottom of blind hole



Hand Taps

Another Method of Identifying Taps :

- Use of annular ring(s) cut around top of shank



Hand Taps

Metric Taps

- Several thread forms and standards in metric thread system

- International Standards Organization (ISO) has adopted standard metric thread
  - Will be used in US, Canada and other countries
  - Have only 25 thread sizes (1.6 to 100 mm)

- Available in sets of three: taper, plug and bottoming taps
  - Identified by letter M followed by nominal diameter of thread in mm times pitch in mm

Hand Taps

Tap Drill Sizes for Metric Taps

Tap drill size for metric taps calculated in same manner as for U.S. Standard threads

TDS = major diameter (mm) – pitch (mm)

Example:

Find the tap drill size for a 22 – 2.5 mm thread

TDS = 22 – 2.5

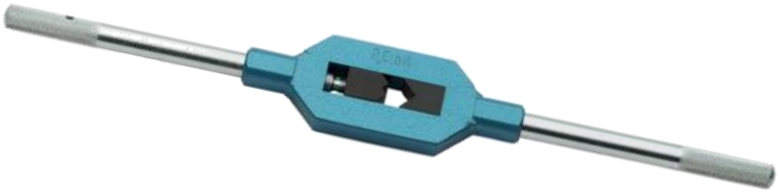
= 19.5 mm

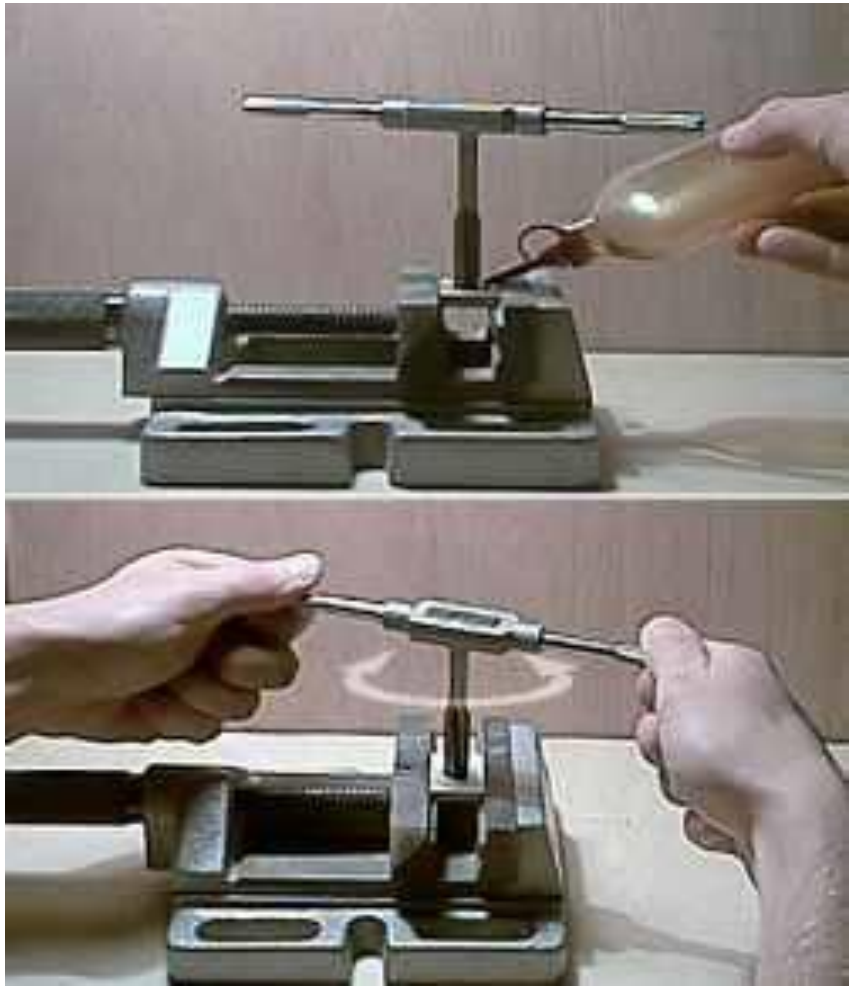
INTERNAL THREAD CUTTING

- Twist drill

- Tap

- Tap wrench





To Tap Hole By Hand :

1. Select correct taps and tap wrench for job.

2. Apply suitable cutting fluid to the tap.
   - No fluid required for tapping brass or cast iron.

3. Place tap in hole as vertically as possible; press downward on wrench, applying equal pressure on both handles; turn clockwise (for right-hand thread) for two turns.

To Tap Hole By Hand :

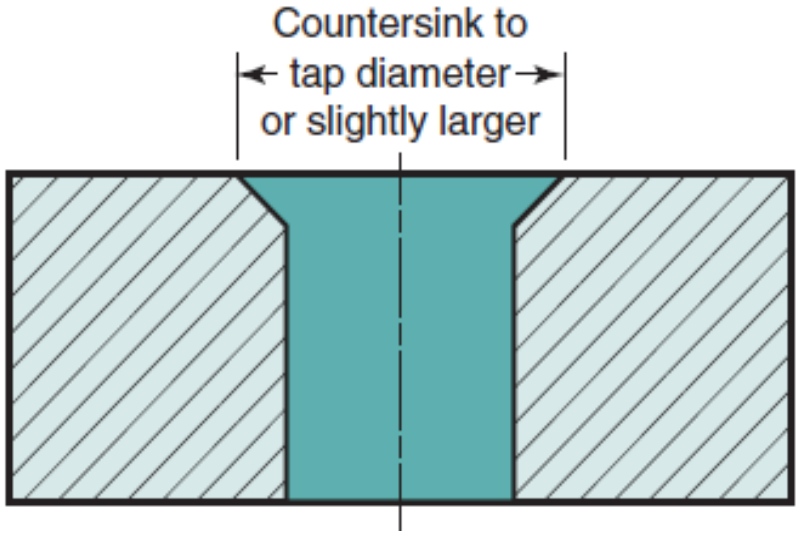
4. Remove tap wrench and check tap for square ness.
   - Check two positions at 90º to each other.

5. If tap not entered squarely, remove from hole and restart it by applying pressure in direction from which tap leans.

6. When tap properly started, feed it into hole by turning tap wrench.

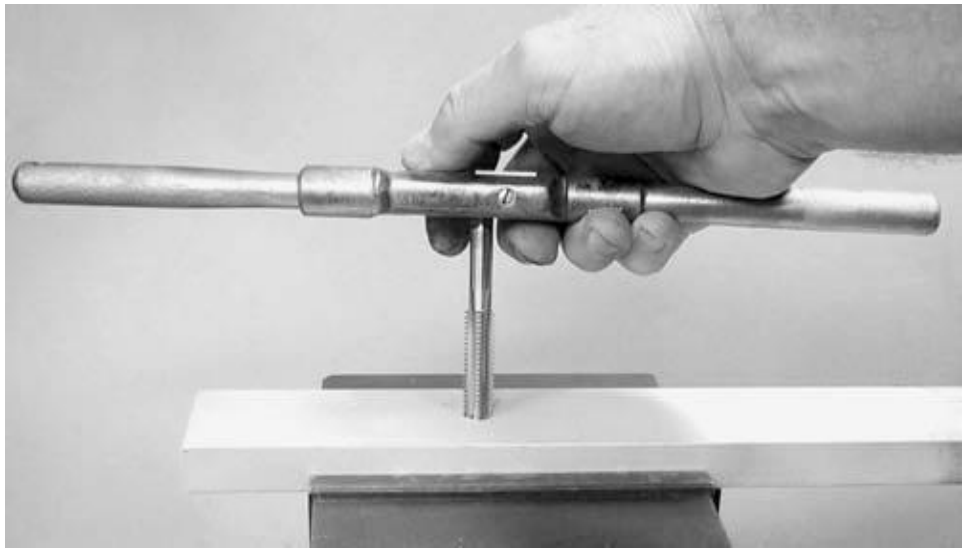
7. Turn tap clockwise one-quarter turn, and turn it backward about ½ turn to break the chip (must turn with steady motion).

Hand Tap procedures :

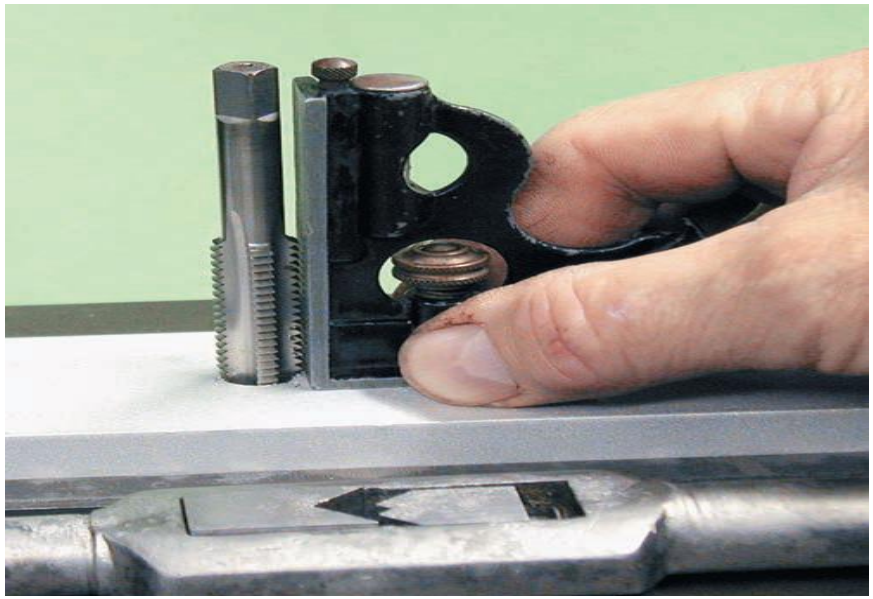


Prepare the work piece

Starting the tap



Hand Tap procedures :



Check the tap for squareness

Start the tap by hand

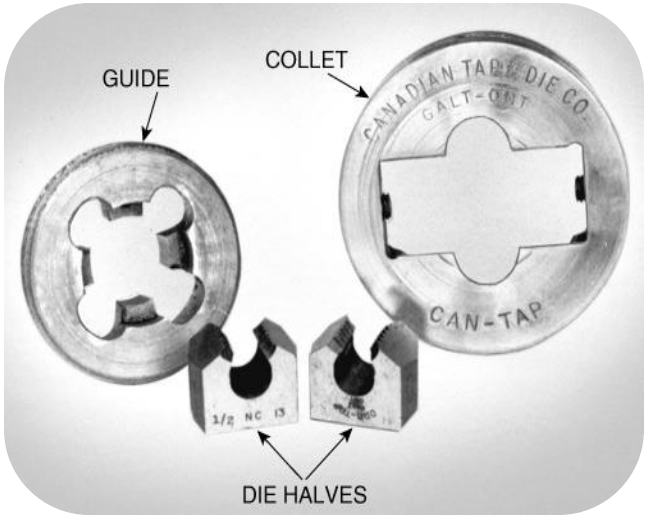
Threading Dies :

- Used to cut external threads on round work
- Most common threading dies
  - Adjustable split die
  - Adjustable screw plate die
  - Solid die
    - Used for chasing or re-cutting damaged threads
    - May be driven by suitable wrench
    - Not adjustable

Threading Dies :

- Adjustable split die
  - Has adjusting screw that permits adjustment over or under standard depth of thread
  - Fits into die stock

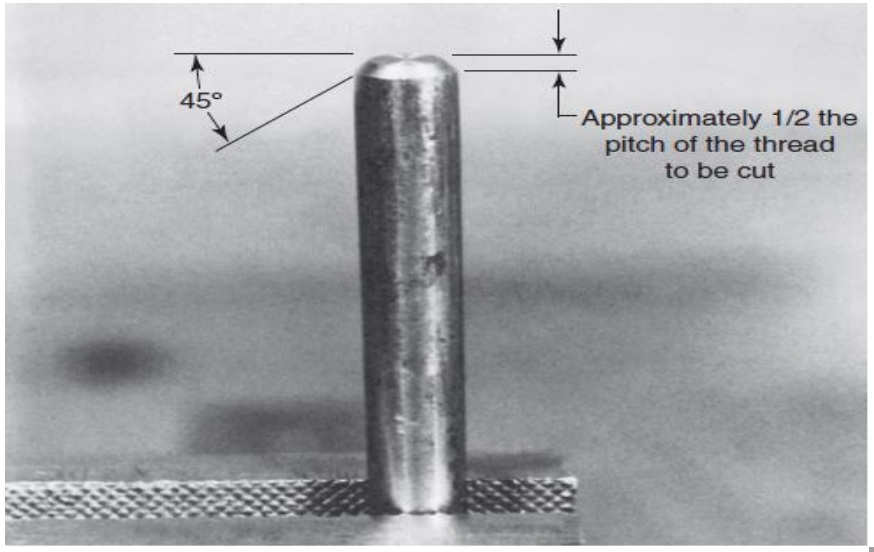
- Adjustable screw plate die
  - Two die halves held in collet by threaded plate
  - Adjusting screws against each die half
  - Greater adjustment than split die



To Thread With a Hand Die :

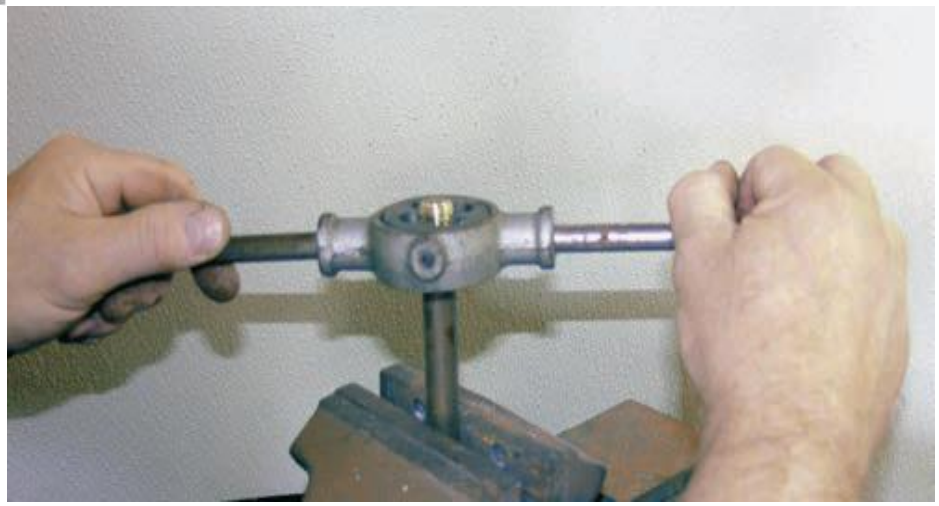
1. Chamfer end of work piece with file or on grinder
2. Fasten work securely in vise
3. Select proper die and die stock
4. Lubricate tapered end of die with suitable cutting lubricant
5. Place tapered end of die squarely on work piece
6. Press down on die stock handles and turn clockwise several turns
7. Check die to see that it has started squarely with work
8. If not square, remove die and restart
9. Turn die forward one turn and reverse it approximately one-half turn to break chip
10. During threading process, apply cutting fluid frequently

Threading Dies Procedures :



Chamfer workpiece before using die.

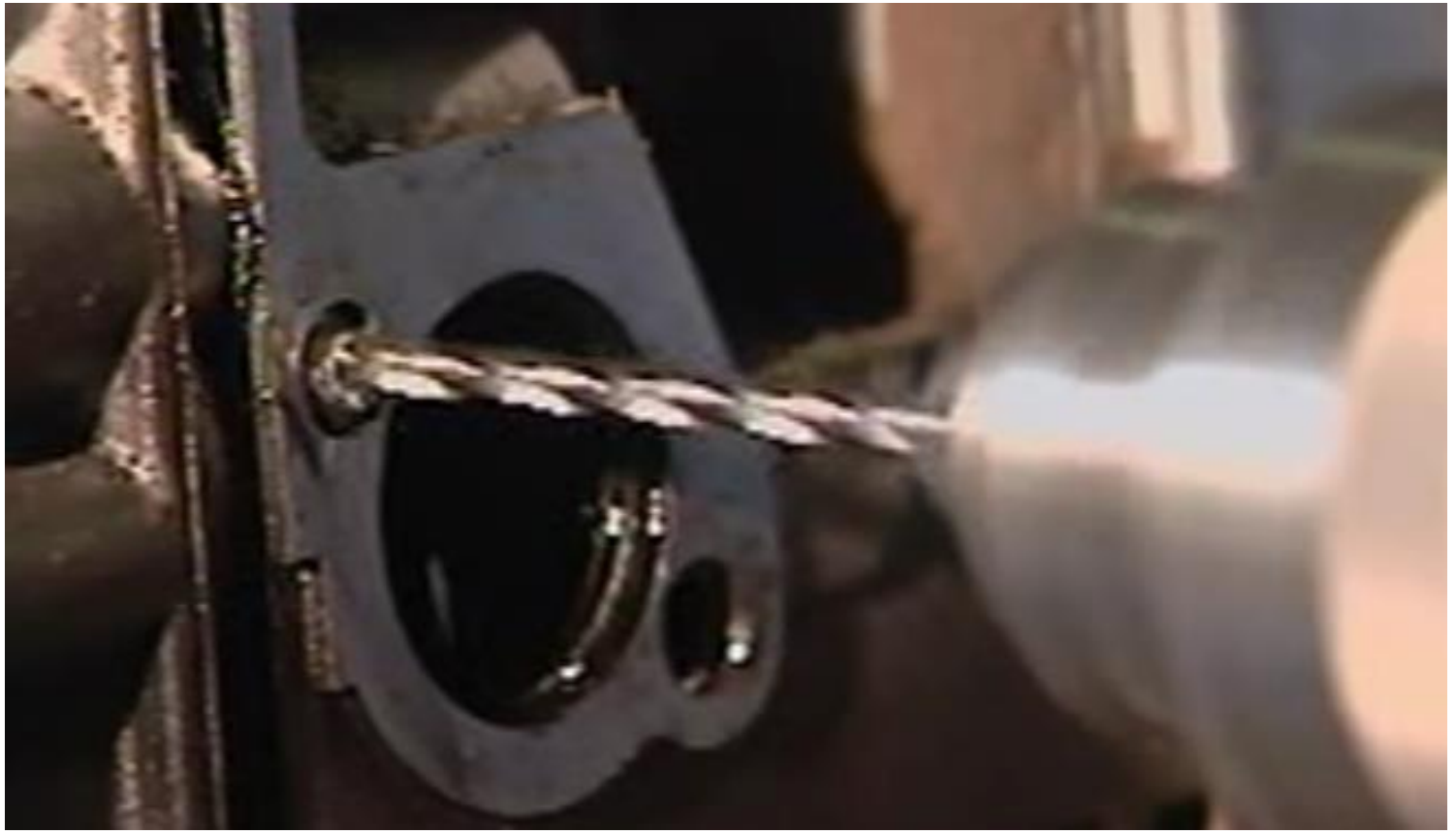
Use both hands to turn the threading die.



Bolt Extractors

- There are many types of bolt extractors on the market.
- You should have at least one type in your tool box.

Drill a hole into the broken bolt



Screwed in the Extractor

Midterm

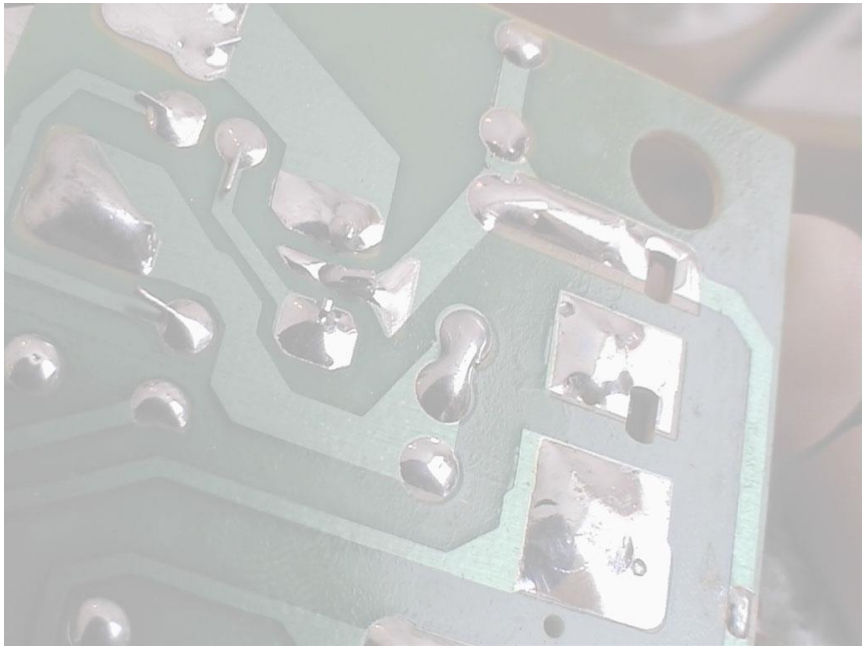
Tools & Equipments, Mechanical Skills

Part 3

WHAT IS SOLDERING?

Soldering is the process of joining metal leads, creating a mechanical and electrical bond.

As shown in the figure, the lead of the resistor and the pad of the circuit board are mechanically attached and electrically connected.



Soldering Equipments :

Soldering Gun

Soldering Wire

Soldering Iron Stand

Temperature controlled

Soldering Parts:

SOLDERING

CLEAN THE POINT OF THE IRON-

take away dirt on a damp (not soaking wet) sponge when the iron is heated up.

This will help your solder to flow properly.

SOLDERING

”TIN” THE IRON.

This just means you should melt a tiny bit of solder onto the point.

Try to avoid breathing in the fumes - they can be harmful.

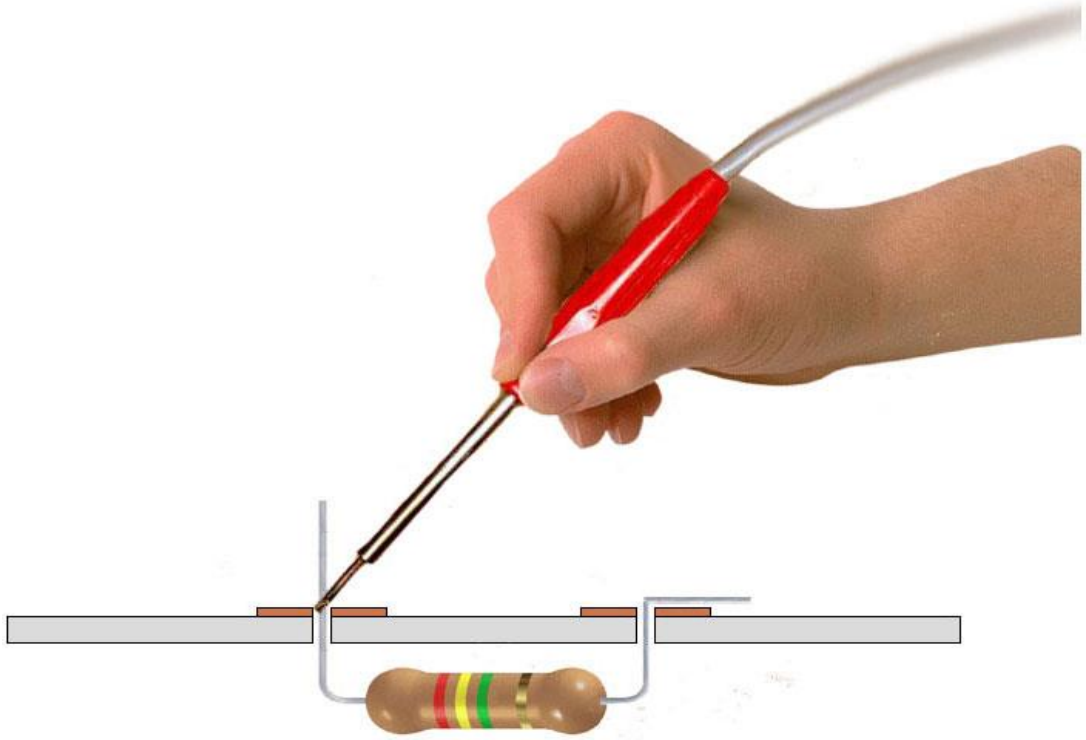
SOLDERING

HEAT YOUR COPPER TRACK

by holding the iron's point on it for 3 seconds.

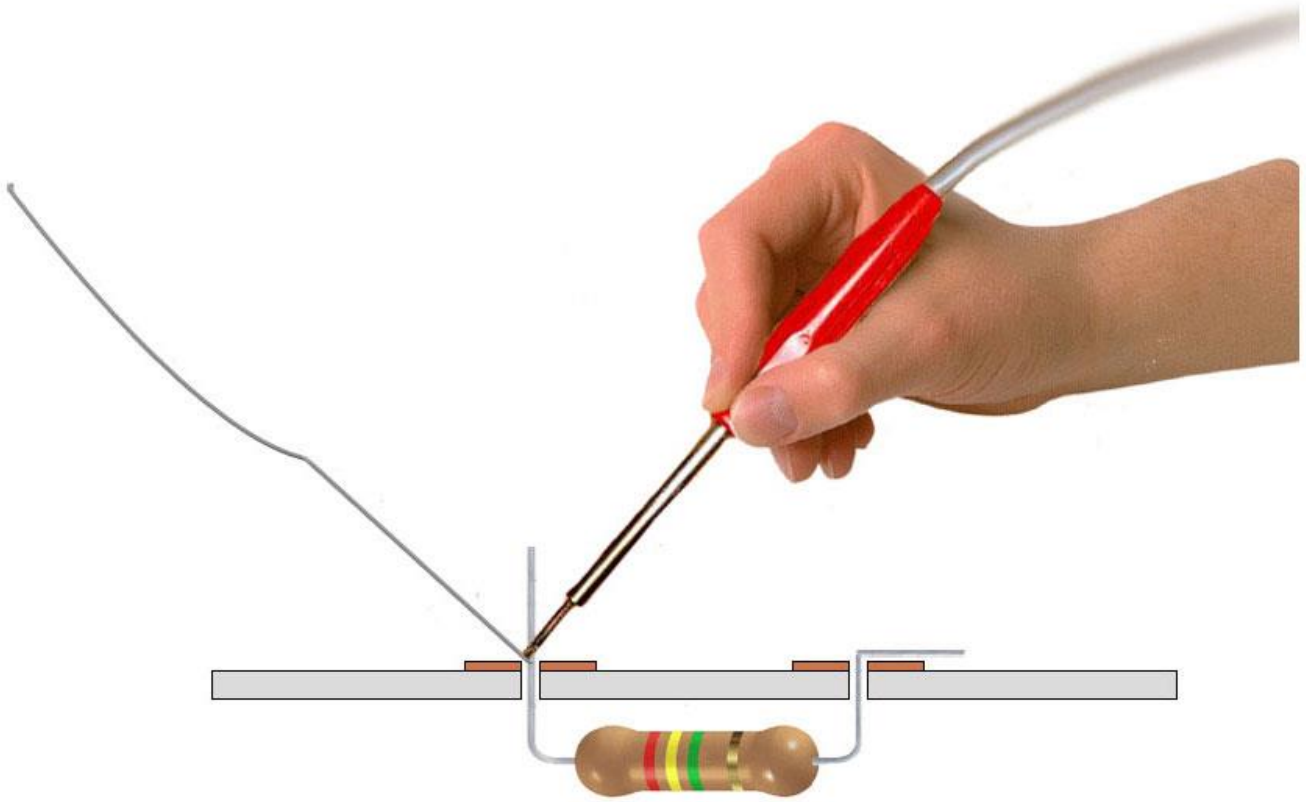
If you heat it for too long, the track will burn away.

If you don't heat it for long enough, the solder will not stick.



SOLDERING

TOUCH THE SOLDER WIRE ONTO THE TRACK
and heat it quickly from above with the iron.

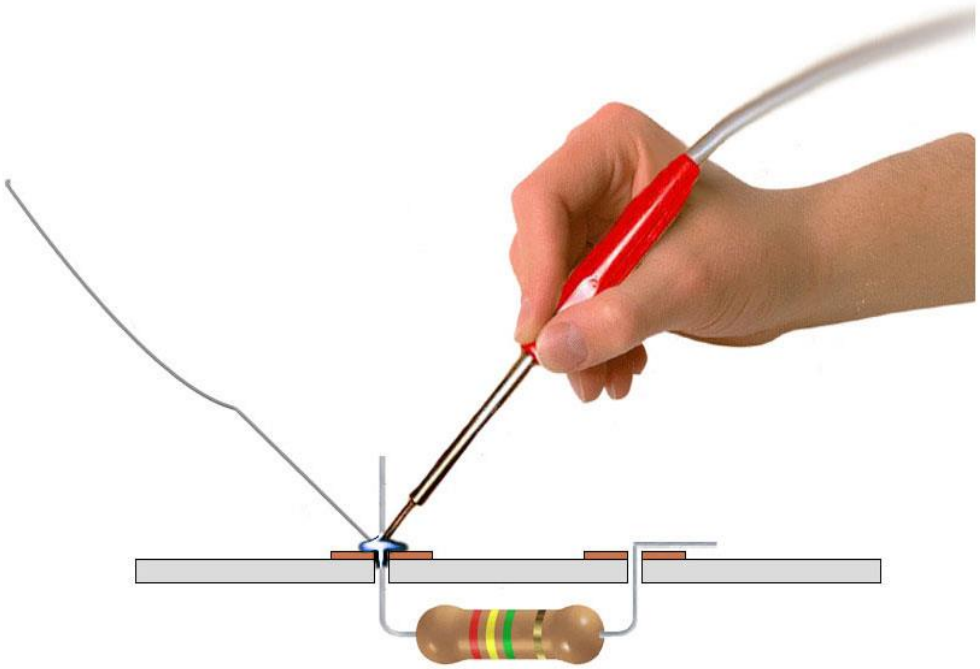


SOLDERING

LIQUIFY JUST ENOUGH SOLDER TO MAKE THE JOIN
and then pull the iron away.

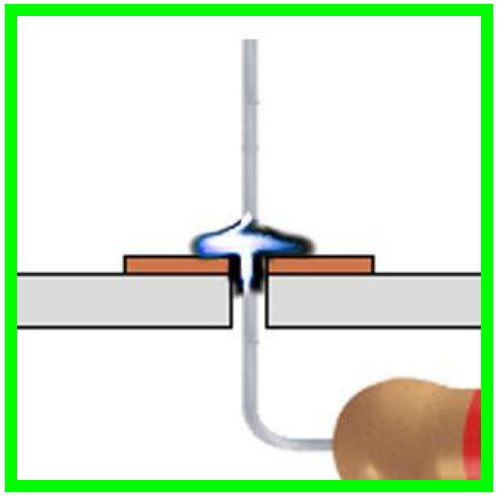
Your join should look something like this one.

You should only need a small amount of solder for each join.



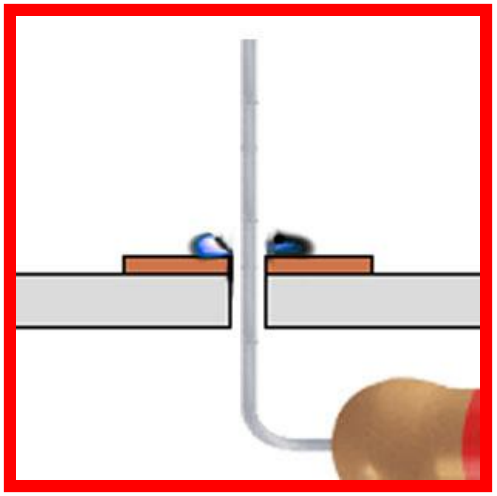
SOLDERING

GOOD AND BAD ATTEMPTS



GOOD:

The join is complete and will hold in place.

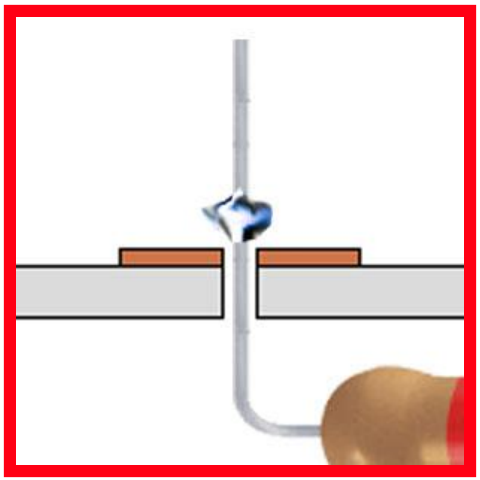


BAD:

Not enough solder applied. No join.

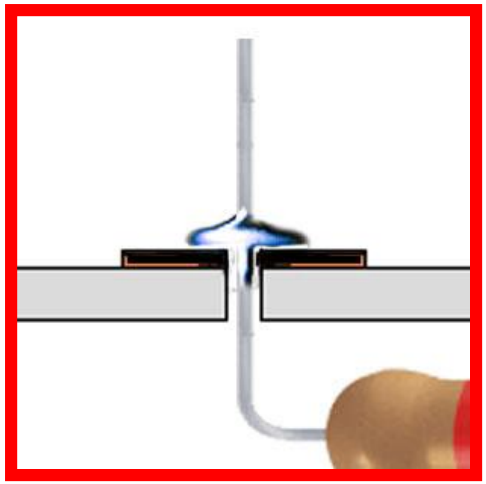
SOLDERING

GOOD AND BAD ATTEMPTS



BAD:

Copper track not heated long enough. No join.

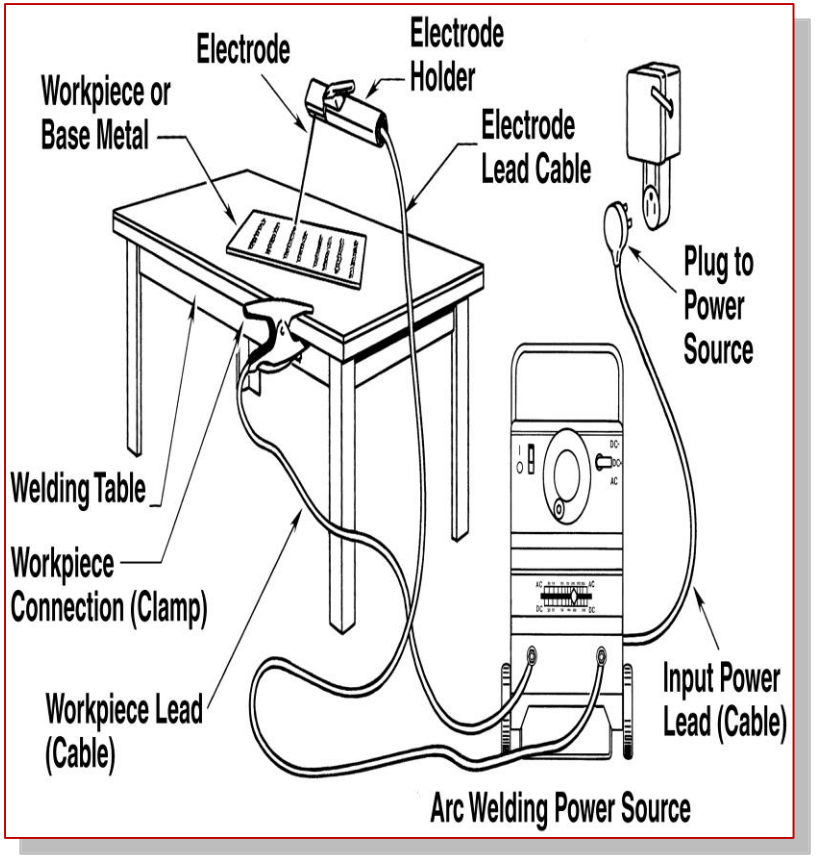


BAD:

Copper track burned so no current can pass through. No join.

SMAW Principles

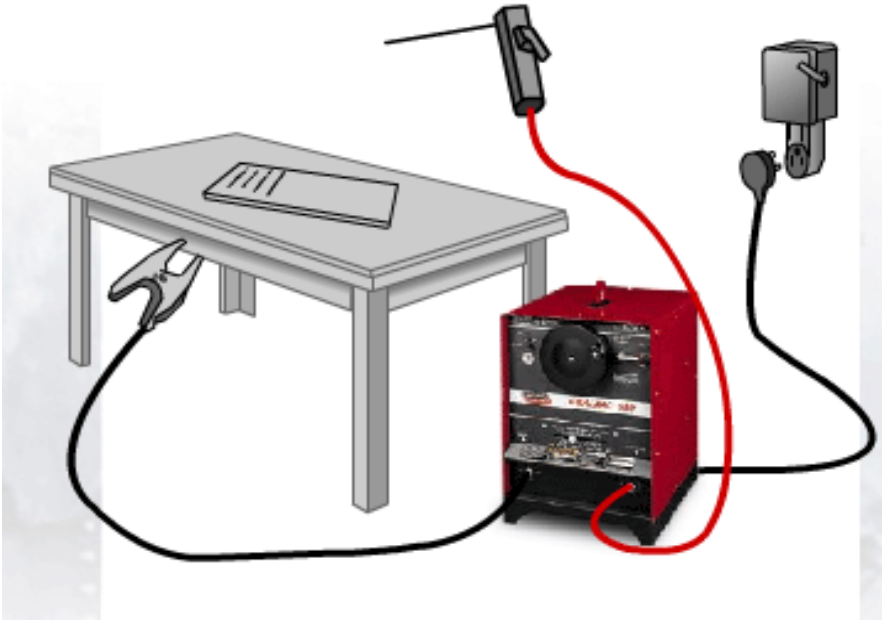
- The American Welding Society defines SMAW as Shielded Metal Arc Welding
- SMAW:
  - Is commonly known as ‘Stick’ welding or manual arc welding
  - Is the most widely used arc welding process in the world
  - Can be used to weld most common metals and alloys



SMAW Welding Circuit

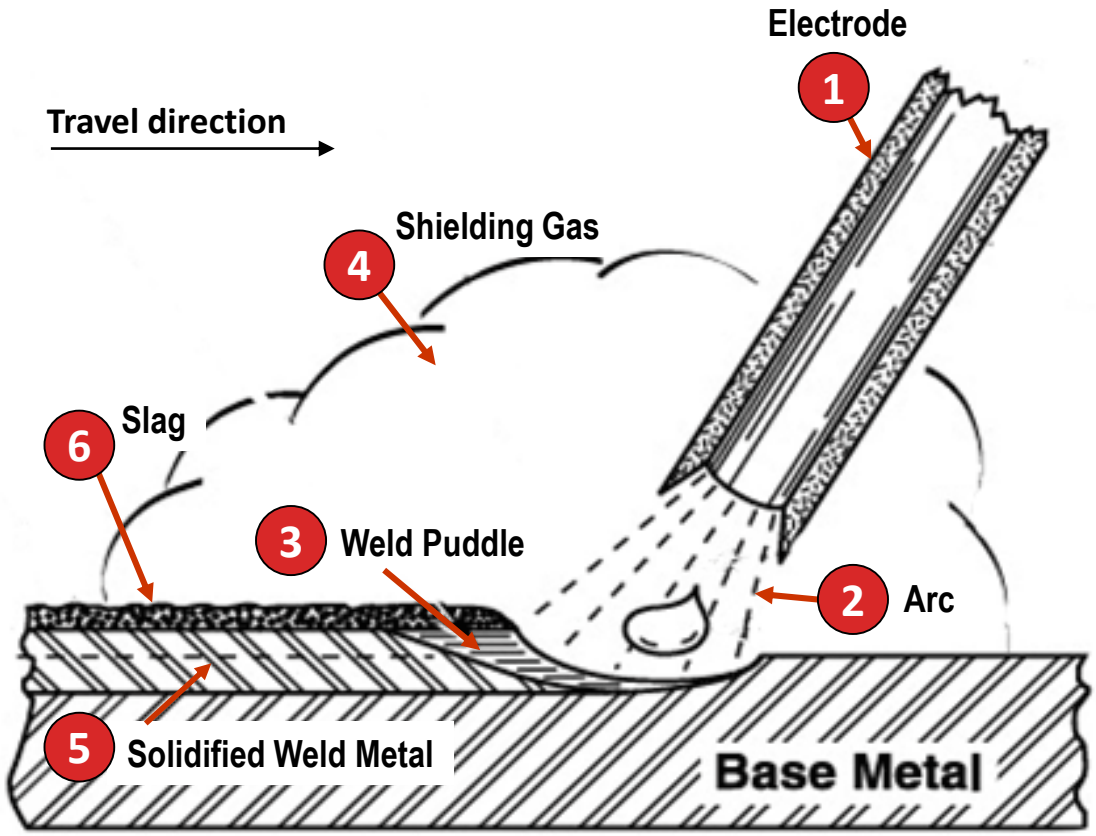
- Current flows through the electrode cable, to the electrode holder, through the electrode, and across the arc

- On the work side of the arc, the current flows through the base material to the work clamp and back to the welding machine .



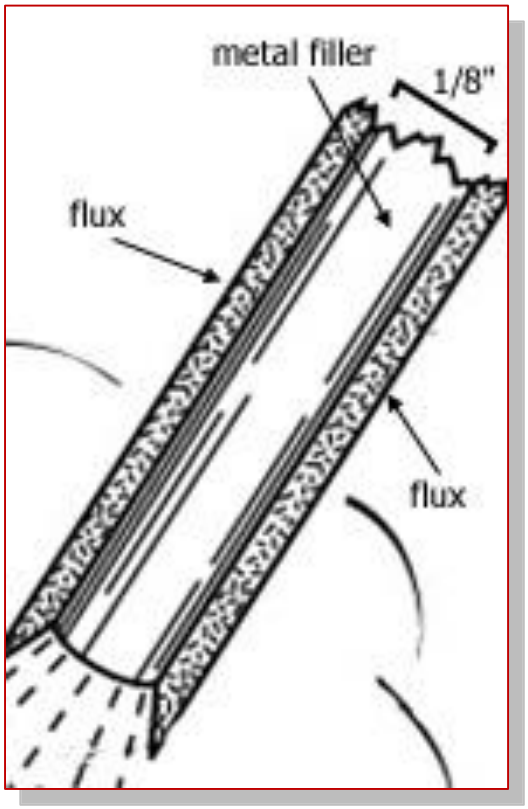
SMAW Process

Let's take a little closer look at the SMAW process…



The Electrode

- Is a consumable - it gets melted during the welding process
- Is composed of two parts
  - Core Rod (Metal Filler)
    - Carries welding current
    - Becomes part of the weld
  - Flux Coating
    - Produces a shielding gas
    - Can provide additional filler
    - Forms a slag



The Arc

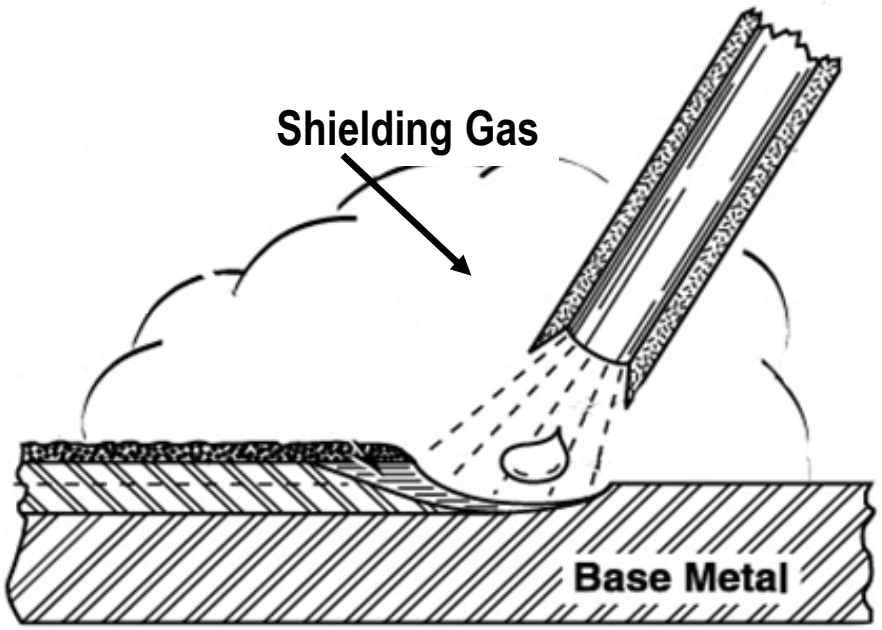
- An arc occurs when the electrode comes in contact with the work-piece and completes the circuit … like turning on a light!
- The electric arc is established in the space between the end of the electrode and the work
- The arc reaches temperatures of 10,000°F which melts the electrode and base material

Weld Puddle

- As the core rod, flux coating, and work pieces heat up and melt, they form a pool of molten material called a weld puddle.
- The weld puddle is what a welder watches and manipulates while welding.

1/8” E6013 at
125 Amps AC

Shielding Gas



The shielding gas protects the molten puddle from the atmosphere while stabilizing the arc.

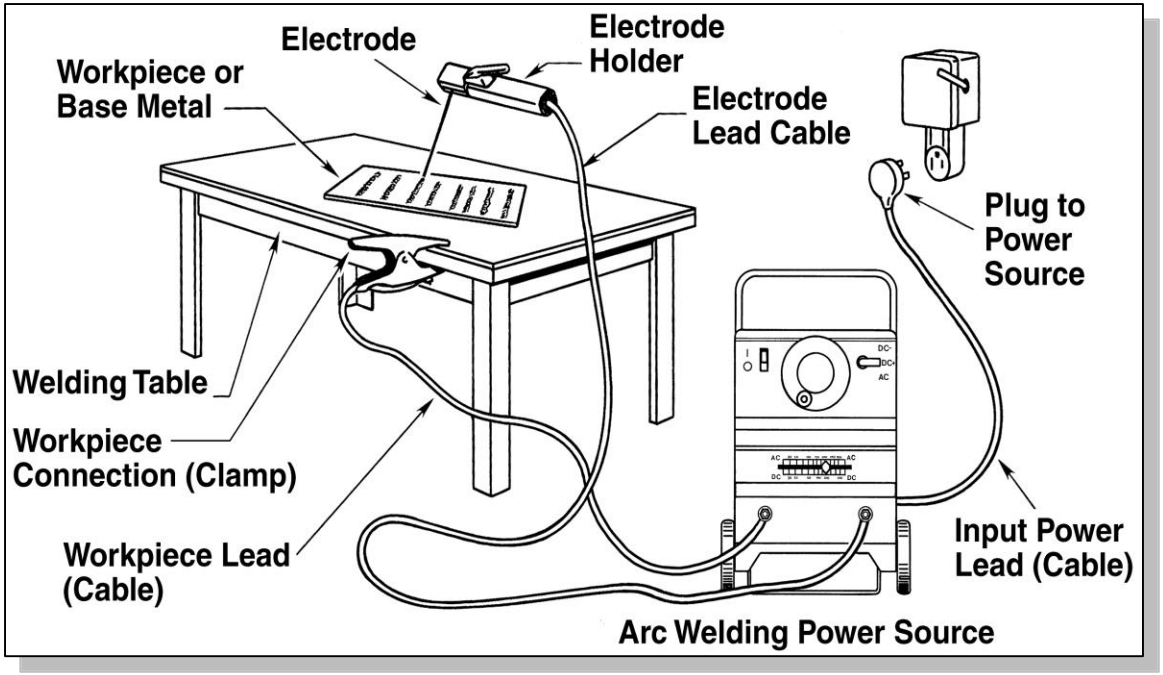
- A shielding gas is formed when the flux coating melts.
- This protects the weld puddle from the atmosphere preventing contamination during the molten state

Solidified Weld Metal

- As the molten weld puddle solidifies, it forms a joint or connection between two pieces of base material.
- When done properly on steel, it results in a weld stronger than the surrounding base metal

SMAW Equipment Set Up

1. Turn power supply on
2. Connect work clamp
3. Select electrode
   a. Type
   b. Diameter
4. Adjust output
   a. Polarity
   b. Amperage
5. Insert electrode into electrode holder .



SMAW Process Variables

- Settings on the machine
  - Polarity : AC, DC+, DC-
  - Amperage Output
- Operator Controlled Variables
  - Work Angle
  - Travel Angle
  - Arc Length
  - Travel Speed

A straight AC machine will not have a polarity switch like this AC/DC machine

Striking an Arc

- To begin the SMAW Process, you must first strike an arc. This can be done using one of the following techniques:
  - Scratch start – scratch the electrode on the base metal like a match
  - Tap Start – tap the rod against the base metal

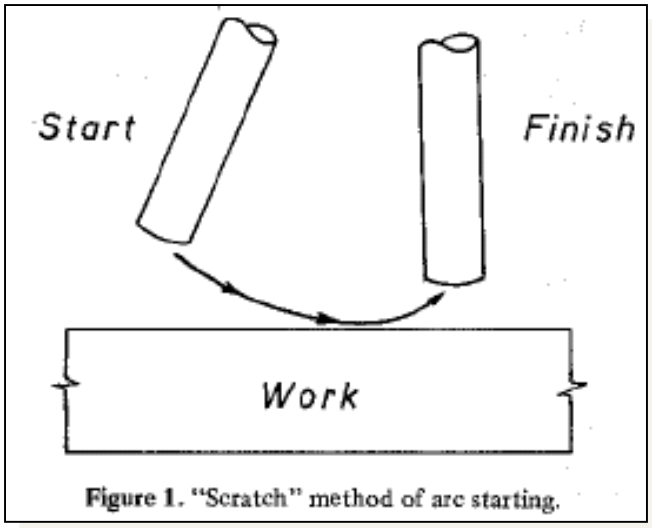


Figure 1. "Scratch" method of arc starting.

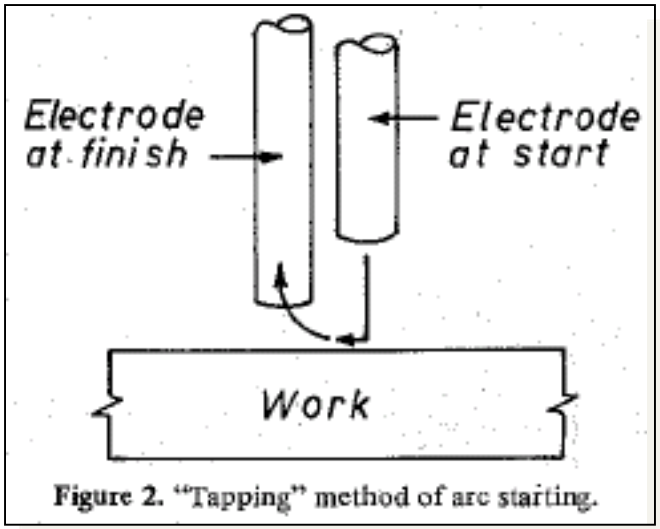
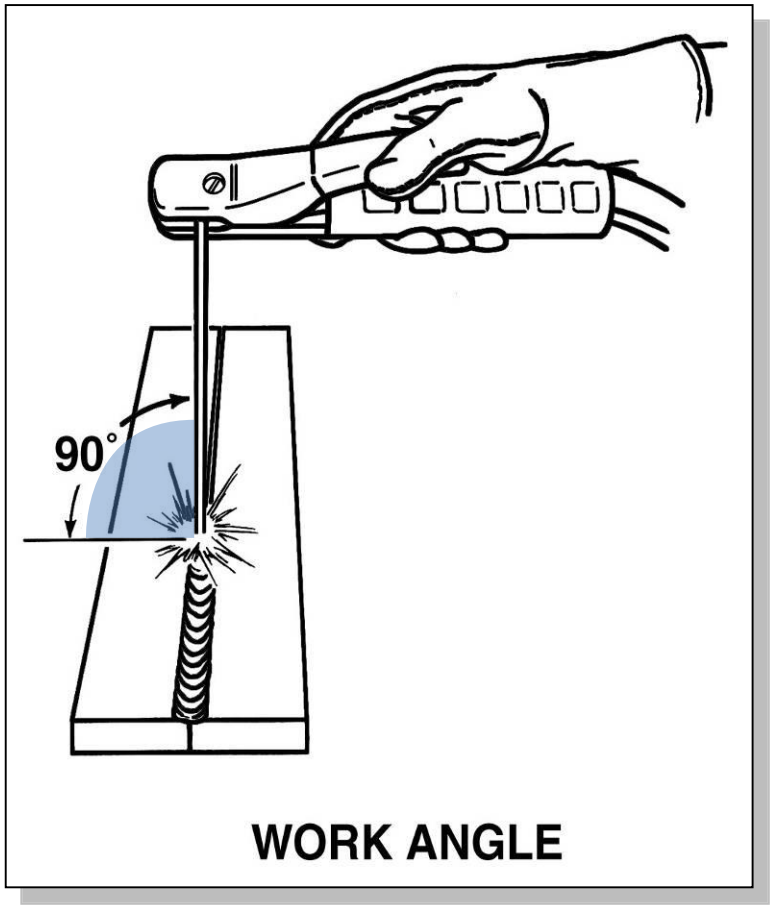


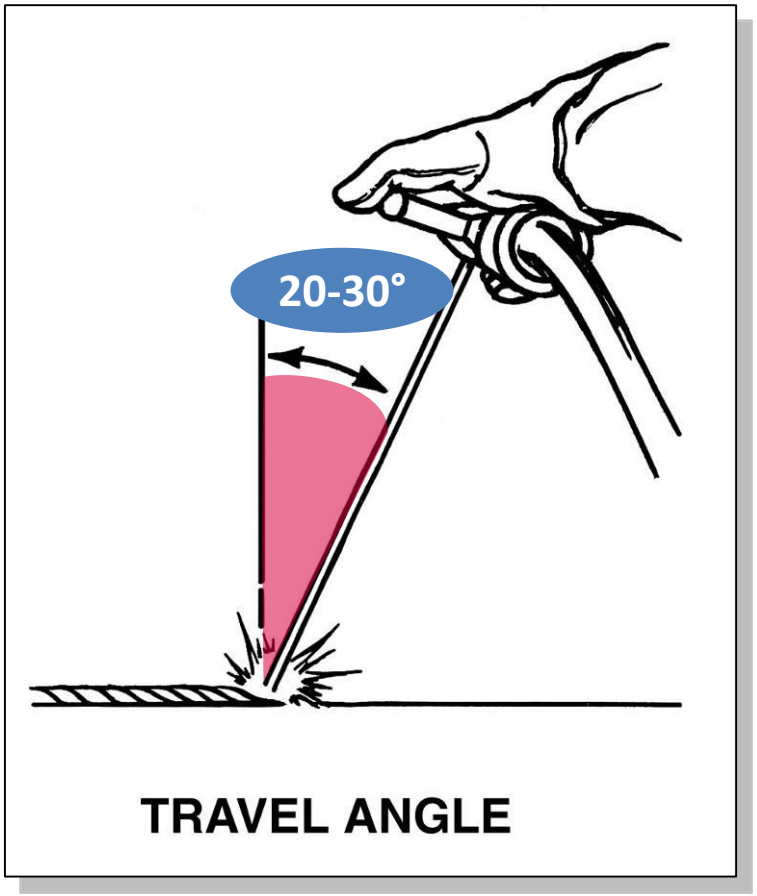
Figure 2. "Tapping" method of arc starting.

Work Angle



- The work angle is the angle between the electrode and the work as depicted on the left.
- Work angles can vary depending on the position the weld is being made in

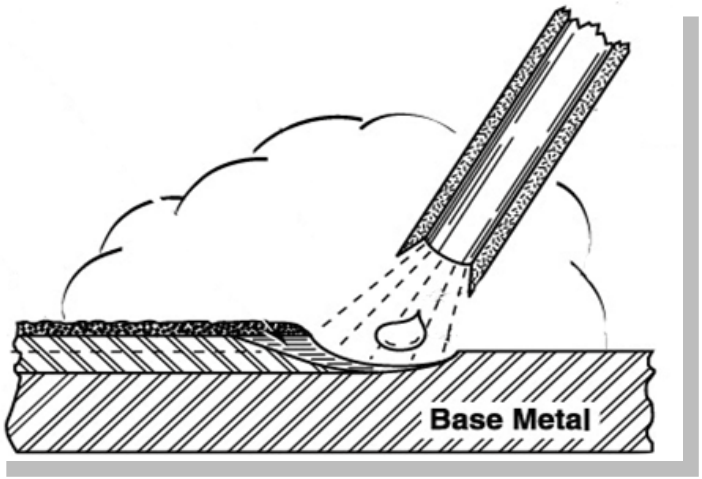
Travel Angle



- Also commonly called Lead Angle.
- The travel (lead) angle is the angle between the electrode and the plane perpendicular to the weld axis

Arc Length

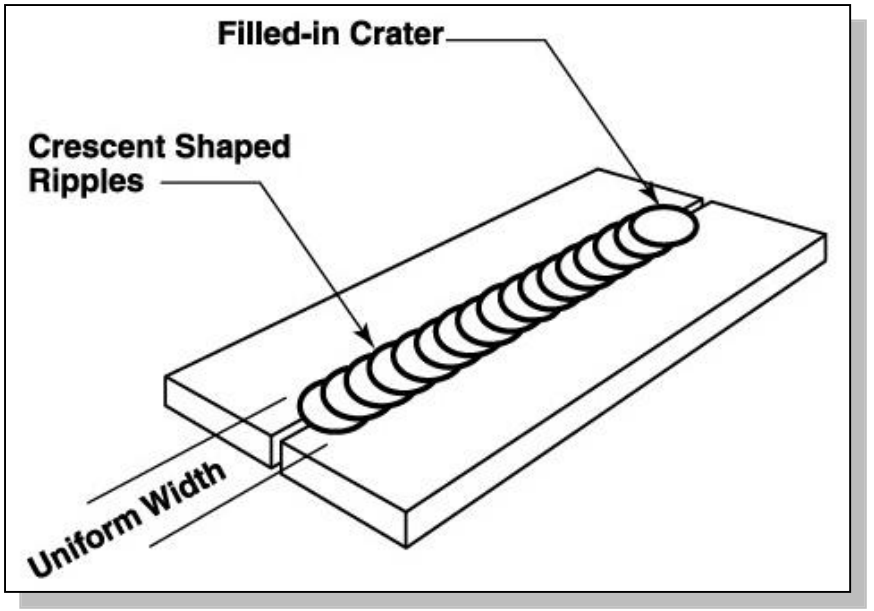
- After striking the arc, maintain a 1/8” distance between the electrode and the work piece.
  - If the arc length becomes too short, the electrode will get stuck to the work piece or ‘short out’
  - If the arc length becomes too long; spatter, undercut, and porosity can occur.



Arc Length = 1/8”

Travel Speed

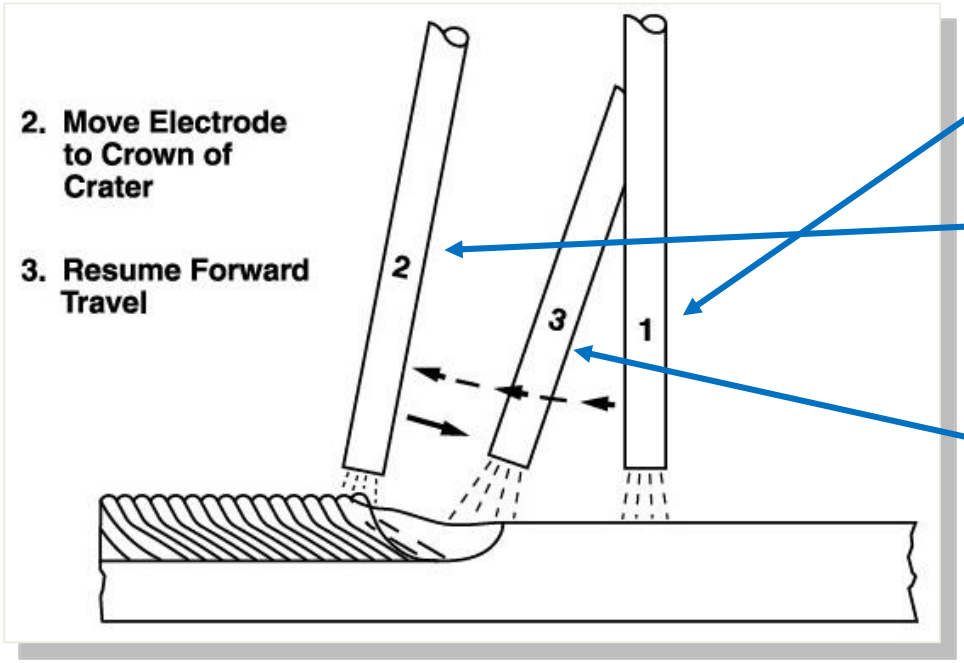
- The travel speed is the speed at which the electrode moves along the base material while welding.
  - Too fast of a travel speed results in a ropey or convex weld.
  - Too slow of a travel speed results in a wide weld with an excessive metal deposit.



The travel speed impacts the shape of the bead.

Restarting a Bead

- Here is the proper technique for restarting a weld:



1. Strike Arc Here

2. Move Electrode to Crown of Crater

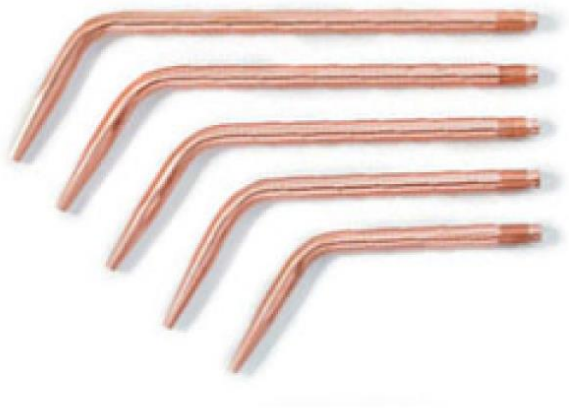
3. Resume Forward Travel

Oxyacetylene Equipment

- Major parts
  - Cart
  - Cylinders
  - Valves
  - Regulators
  - Gauges
  - Hoses
  - Torch assemblies

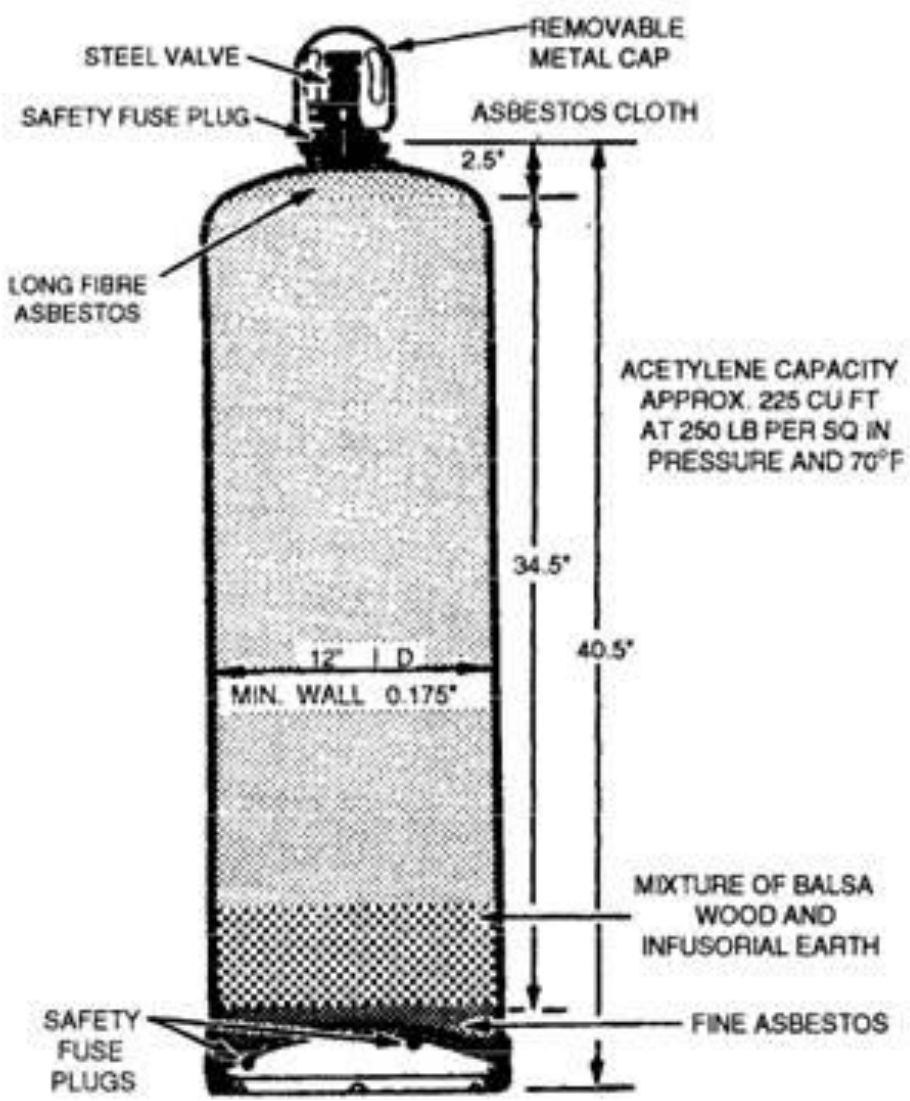
Torch

- Mixes gases and discharges them to support a controllable flame.



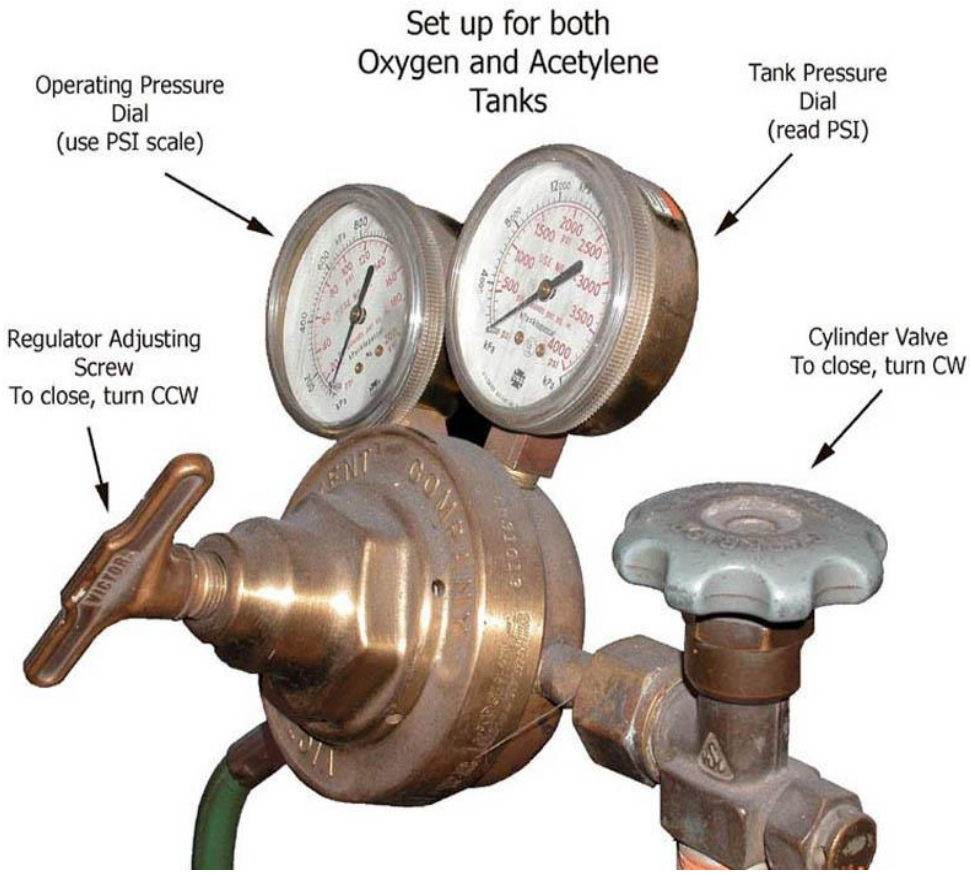
Cylinder

- Long, round tank with extremely thick walls built to hold gases under great pressure



Valves and Regulators

- Control the flow of gas.



Hoses

- Flexible lines that carry the gases
- Made of rubber reinforced with nylon or there material to withstand high pressure and heavy use
- Red= acetylene
- Green= oxygen

The Rig

- Acetylene Side
  - Acetylene cylinder
    - Red or brown
  - Cylinder valve
  - Red cylinder pressure gauge
  - Regulator
  - Hose pressure gauge
  - Red hose
  - Acetylene valve on torch
- Oxygen side
  - Oxygen cylinder
  - Green cylinder pressure gauge
  - Regulator
  - Hose pressure gauge
  - Green hose
  - Oxygen valve on torch
  - Torch mixing chamber
  - Torch tip

Setting Up

- Acetylene
  - Left hand threads
  - Color coded red (brown in our shop)
- Oxygen cylinders
  - Right hand threads
  - Color coded green
- Before attaching regulators to cylinders, crack the cylinder by turning the gas on and off quickly to blow out any dust
  - When attaching regulators, hoses, gauges or torch connections, the connectors must be threaded in the correct direction. The red color coding and opposite threads for acetylene are means of preventing the accidental mixing of acetylene and oxygen except in the torch its self.

Turning On the Acetylene and Oxygen

- Use the following sequence to turn on the gases :

1: Close the acetylene valve on the torch.

2: Close the oxygen valve on the torch.

3: Turn the acetylene regulator handle counter clockwise until no spring tension is felt.

4: Turn the oxygen regulator handle counter clockwise until no spring tension is felt.

Turning on Oxygen and Acetylene

5: Open the oxygen cylinder valve slowly until the pressure gauge responds. Open the valve all the way.

6: Open the acetylene cylinder valve slowly half a turn
- NEVER open the acetylene cylinder more than half a turn. This is so it can be shut off quickly in the case of emergency.

7: Open the oxygen torch valve an 1/8 of a turn. Turn the oxygen regulator handle clockwise until the pressure gauge reads 10 psi.

Turning on Oxygen and Acetylene

8: Open the acetylene torch valve an 1/8 of a turn. Turn the acetylene regulator handle clockwise until the pressure gauge reads 5 psi. Close the acetylene valve.

- Step 7 & 8 purge the lines and set regulators to a safe starting pressure
- Purge the lines: remove undesirable gases
- This makes the unit pressurized and ready to go.

Lighting and Adjusting Torches

- Two types- welding and cutting.
- To light.
- Open the acetylene valve an eighth of a turn.
- Use a spark lighter to ignite the torch
  - NEVER use matches or a lighter!
  - DO NOT point the torch directly into the lighter.
  - DO NOT point the torch towards other people.
- Open the acetylene valve slowly until the flame is ¼" off the tip of the torch, increase or decrease the flow until the flame just touches the tip.
  - This flame is called a carbonizing flame.
    - Carbonizing flame is one with excess acetylene.

Lighting and Adjusting Torches

- Turn the oxygen valve on slowly and watch the inner flame shorten. Continue to add oxygen until the long, inner flame just fits the cone.
  - This is a neutral flame.
  - Neutral flame: one with the correct balance of acetylene and oxygen.
  - This flame is correct for heating, cutting, and welding
- If additional oxygen is added, the cone becomes sharp and the flame noisy. This is an oxidizing flame or one with an excess of oxygen.
- It is hottest type of flame but not recommend for anything but special types of applications.

FLAMES

Acetylene burning in air Not suitable for welding.

Strongly Carburizing Flame Metal boils and is not clear.

Slight Excess Acetylene Flame
Similar to neutral flame – little or no pudding is necessary.

Neutral Flame
Metal is clean and clear, flowing easily.

Oxidizing Flame
Excessive foaming and sparking of metal.

Quiz 2