# JOINING METAL INCLUDING TUBE



This mobile revision pdf is based on detailed work found in the JOINTS section.
Tap on the green link button below to go to the complete website section

Tap the blue button to view all joining metal techniques, covered by this Revision PDF

# JOINING METAL INCLUDING TUBE

## 1. NUTS AND BOLTS

## 2. POP RIVETING

## 3. COLD RIVETS

## 4. BRAZING

## 5. WELDING TECHNIQUES

## 6. PLASMA CUTTING

## 7. FITTINGS FOR TUBE, SHAFTS AND WHEELS

## 8. TEMPORARY / PERMANENT JOINTS FOR TUBE – READY MADE JOINTS



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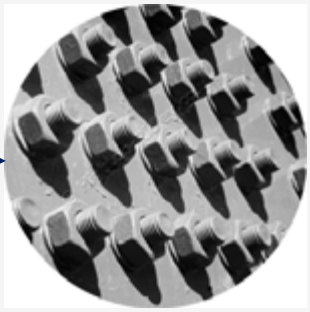
# BOLTS – AN INTRODUCTION



Bolts are used to join pieces together either permanently or temporarily. Many steel structures, including buildings, are simply bolted together. For example, the Eiffel Tower in Paris was originally a temporary structure and after twenty years it was to be dismantled. For this reason most of the steel components were bolted together. However, the tower has lasted well over a hundred years. Much of the structure of the Empire State Building in the USA is also bolted together. Nuts and bolts can also be used to fix together small structures such as furniture. Nuts and bolts come in many different types and sizes and some are shown below.



Tap the blue button for the next JOINTS page.

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# BOLTS – AN INTRODUCTION



The photograph below shows nuts and bolts being used in the construction of the Empire State Building

**Tap the image** for more information

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# BOX GIRDER BRIDGES



Box girder bridges are quite common. They usually manufactured from prefabricated steel girders. This means that the girders are manufactured in a factory and transported to the location of the bridge, where they are fixed together. The steel girders of the bridge are fixed together normally with large **nuts and bolts**. Sometimes rivets are used although these are seen on older structures.

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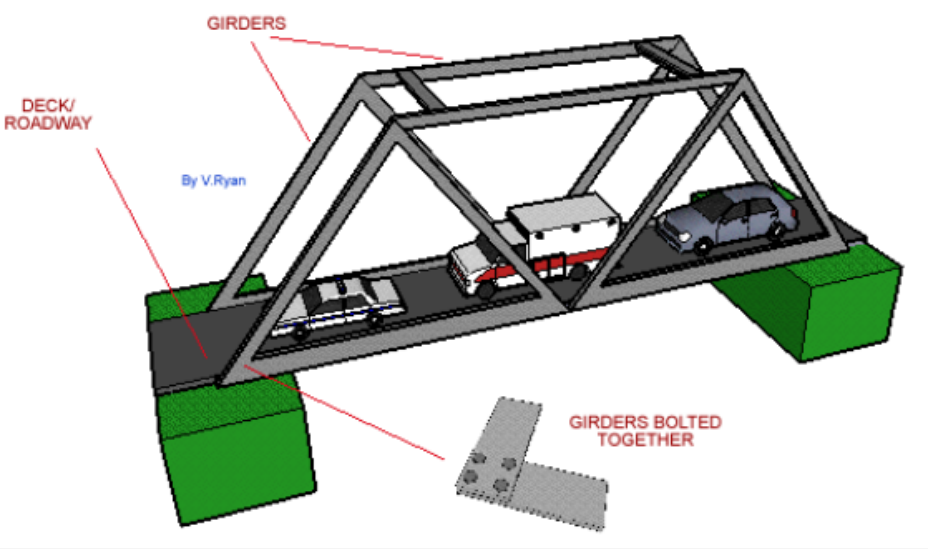


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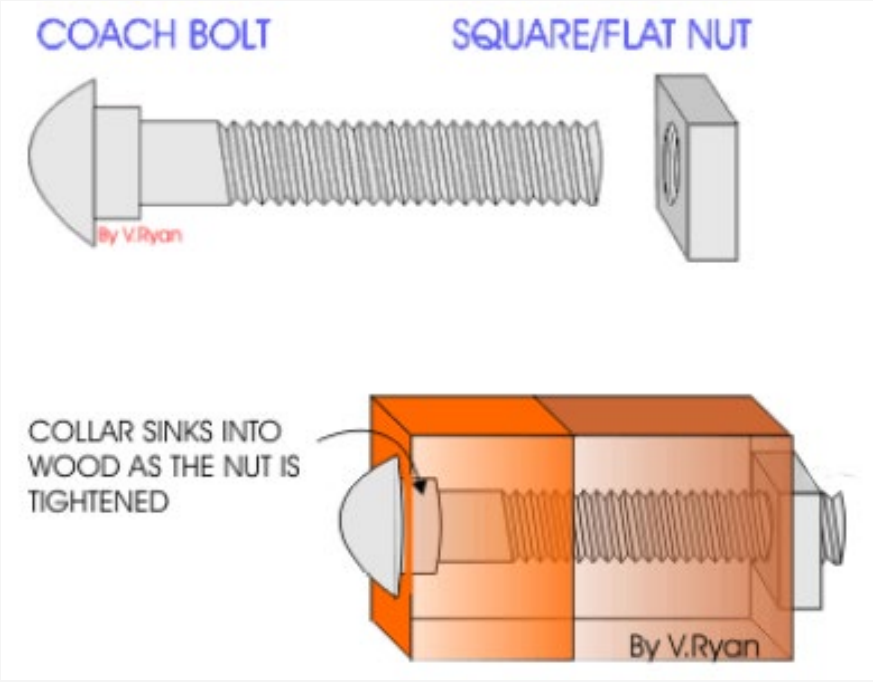
# COACH BOLTS



The coach bolt has a square collar under the domed head and this locks into the wood when the nut is tightened. A washer is normally placed before the nut to stop it sinking into the wood as it is turned.

**Tap the image** for more information

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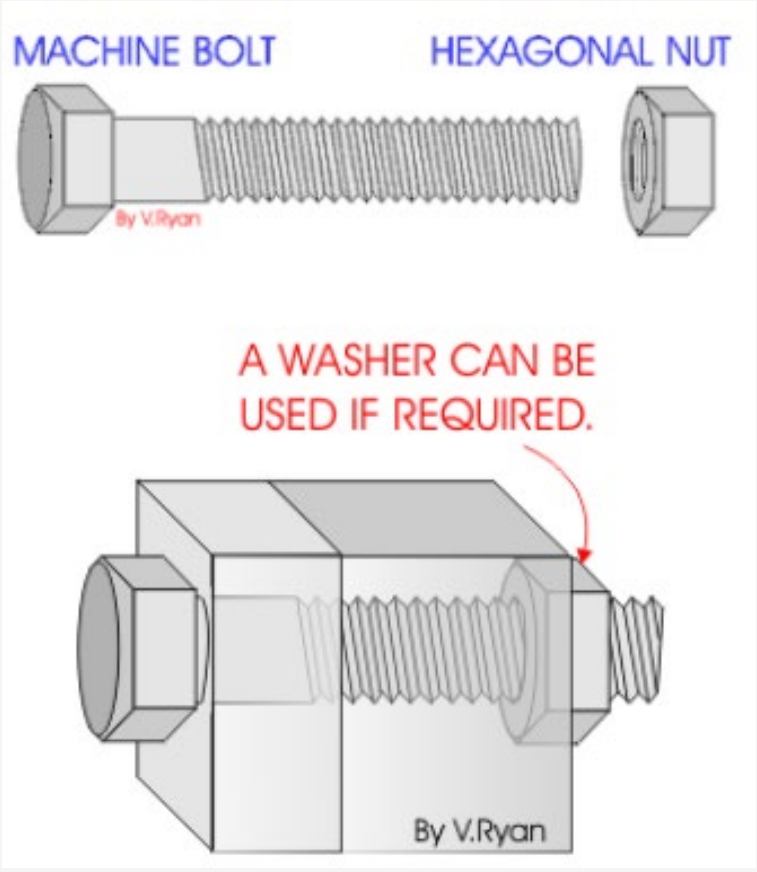
# MACHINE BOLTS



Two spanners are needed to tighten this nut and bolt. The first spanner fits round the hexagonal head of the bolt and a second spanner is used to tighten the hexagonal nut.

**Tap the image** for more information

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# EXERCISE



**Tap the image** for more information and an exercise on coach / machine bolts

Tap the blue button for the next JOINTS page.

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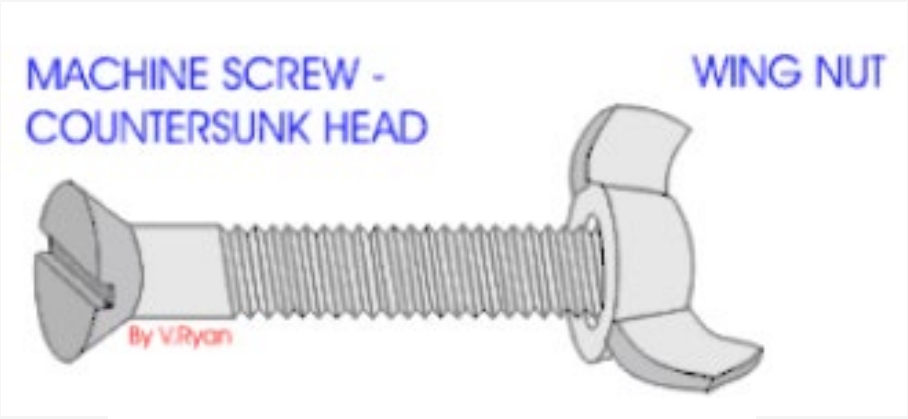
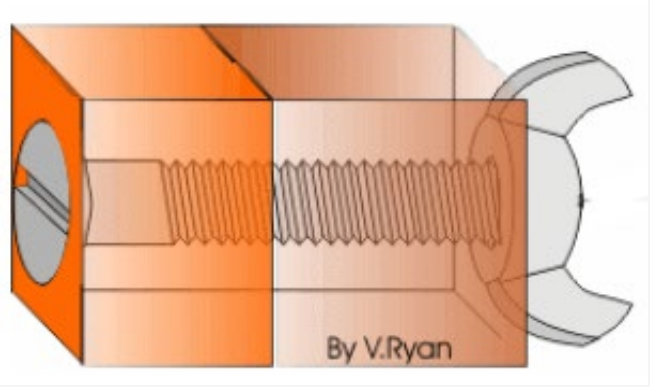
# COUNTERSUNK BOLT AND WING NUT



The countersunk machine screw fits level with the surface of the wood/metal/plastic. A screwdriver is used to keep the bolt still whilst the wing nut is tightened by hand. The 'wings' of the wing nut, are designed to be comfortable when tightening the nut and bolt.

**Tap the image** for more information

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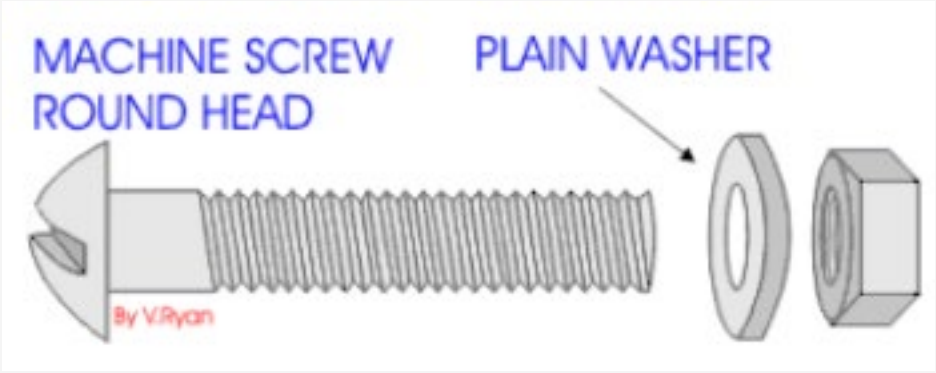
# OTHER COMMON BOLTS

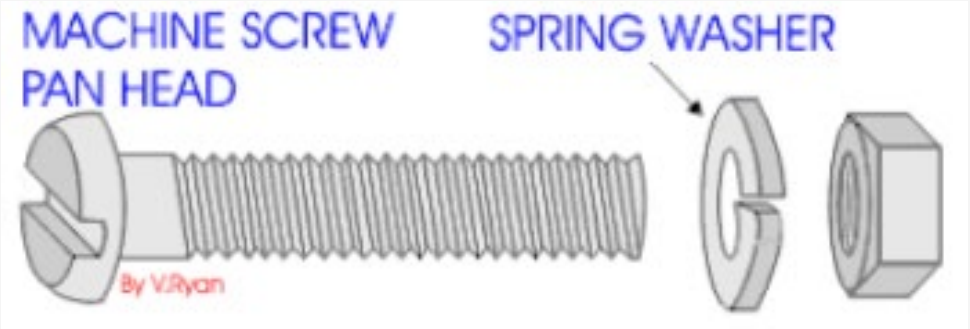


**Tap the images** for more information and an exercise

A plain washer prevents the nut sinking into the surface of the wood/plastic/metal




If there is a need to prevent A nut and bolt loosening a spring washer is used.

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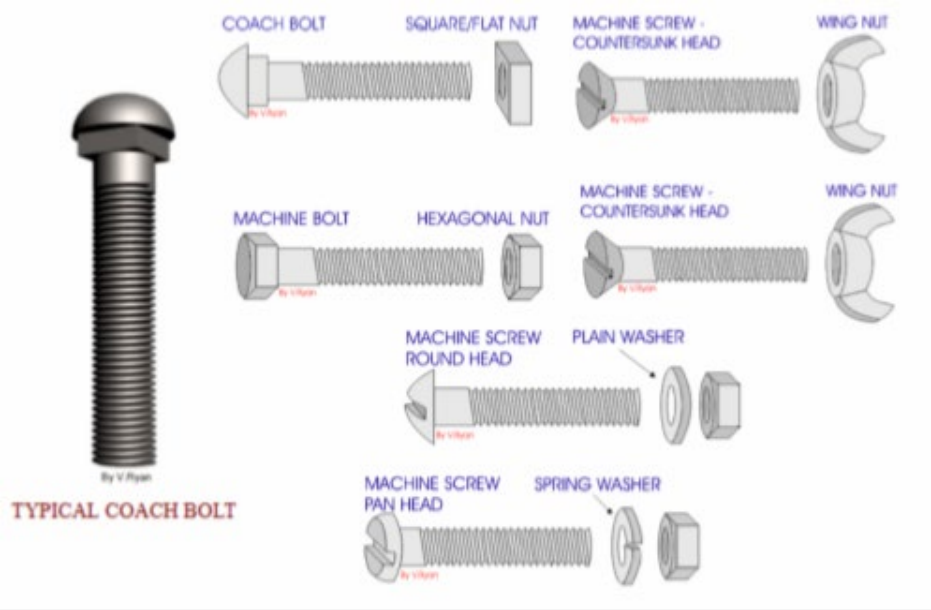
# BOXED LEARNING EXERCISE



**Tap the image** for a revision exercise

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# POP RIVETING



Pop riveting is a technique that is used to join thin pieces of metal and it can also be used to join plastic sheet. The rivet has two parts; the pin and the rivet. The pop rivet pliers are used to pull the pin through the rivet and as this happens the rivet is deformed slightly so that it joins the metal or plastic pieces. This technique is used where the metal or plastic is thin and where the joint does not have to be very strong.

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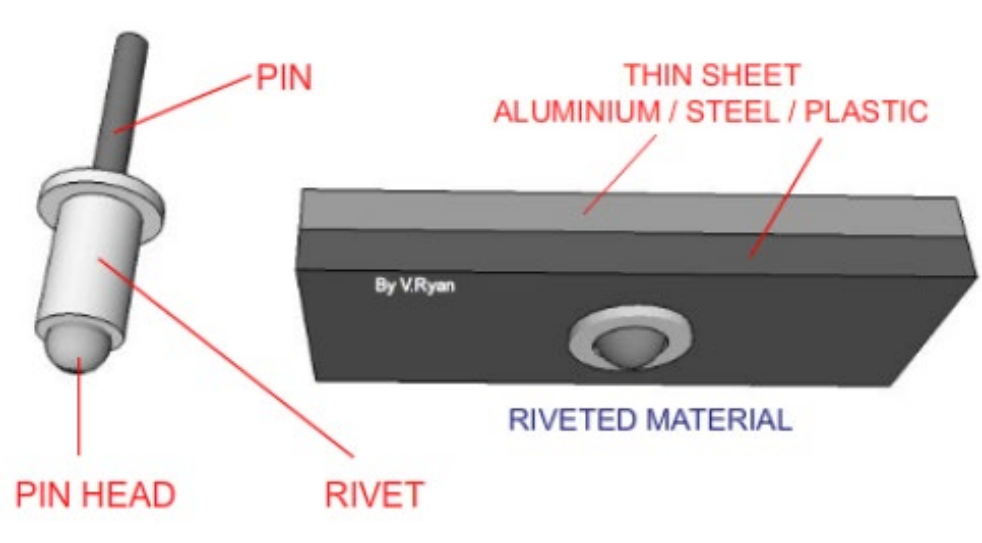


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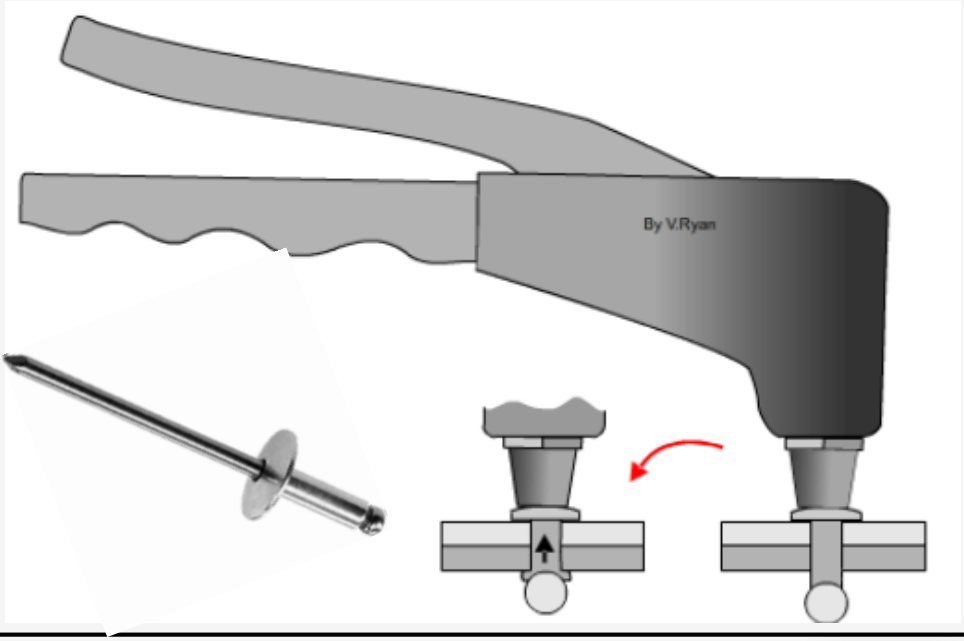
# POP RIVETING



The two pieces of plastic or aluminium are drilled slightly larger than the rivet. The pop rivet is passed through both holes in the sheet plastic / aluminium. Rivet pliers are pushed on to the pin of the rivet and the handles are pulled together. The pin head is pulled into the rivet and the end of the rivet expands. Eventually the pin breaks off, leaving the rivet permanently fixed in position, holding the two pieces of plastic / aluminium together.

**Tap the image** for more information

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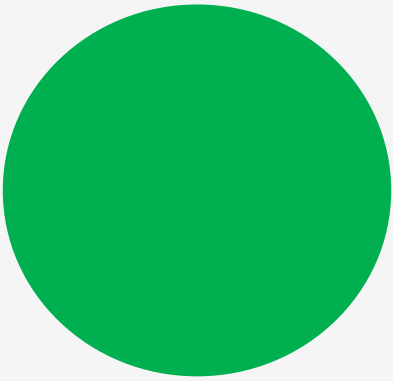
# POP RIVETING - EXERCISES



**Tap the link buttons** for exercises



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# COLD RIVETS - TYPES AND USES



Rivets are used to join plates together and they have been used for hundreds of years. Before the widespread use of welding, rivets were used in heavy industries such as ship building. The steel plates used to build ships such as the Titanic and the naval Dreadnaughts of World War One were held together by steel rivets.
Joining plates together with rivets, is still a useful technique especially if the plates to be joined are quite small.

**Tap the images** for more information


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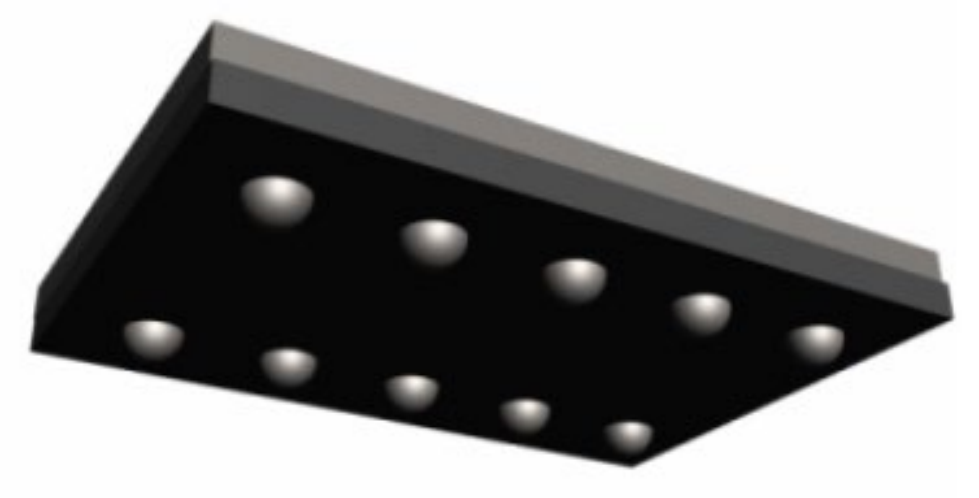
# COLD RIVETS - CONTINUED



Below are two steel plates that have been joined permanently using steel 'snap head' rivets. The plates cannot move a part because the rivets hold them firmly together. The rivets shown above are the main types and the heads of each vary in shape. Snap head rivets have been selected for the work shown below because it does not matter that the heads show above the surface of the metal.

**Tap the image** for more information and exercises



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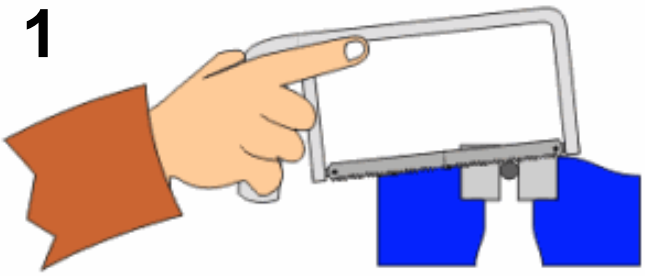
# HOW TO COLD RIVET



**Tap all three images in sequence** for information and animations on the cold riveting technique

1

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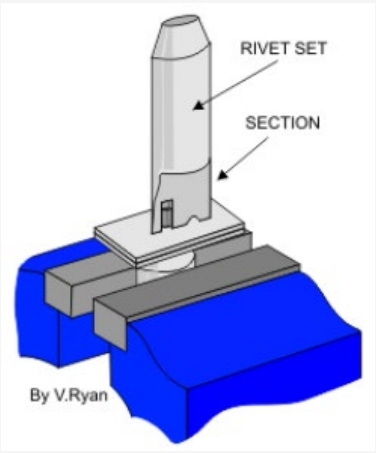


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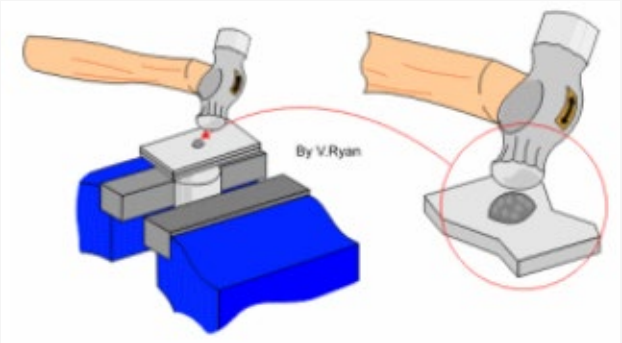


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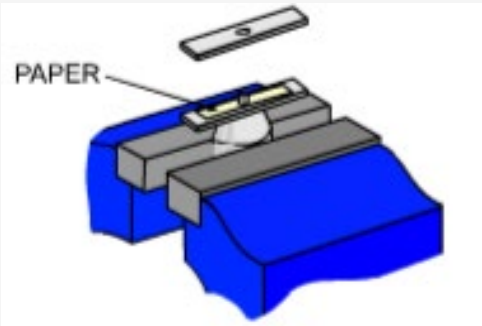
# COLD RIVETS AND MOVEMENT

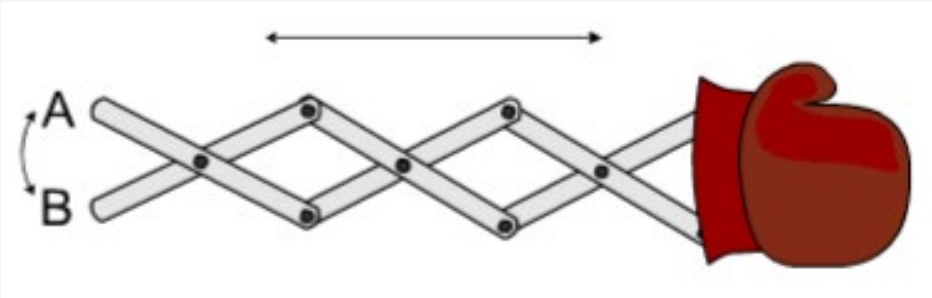


If there is a need for a 'pivot', a joint that allows movement, consider using a riveted joint. Simply place a piece of paper between the two pieces of material and rivet them together.

The gap caused by the paper, allows the joint to move from side to side, a perfect pivot.

**Tap the images** for more information and an exercise

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# BRAZING USING A BRAZING HEARTH



Steel can be joined by using a technique called brazing. A high temperature is needed for this and so a brazing hearth is normally used. Brazing gives a permanent joint that is ideal for most metalworking projects in schools and colleges. In industry this technique is used on products such as bicycle frames where there is a need for a certain amount of flexibility in the joint.

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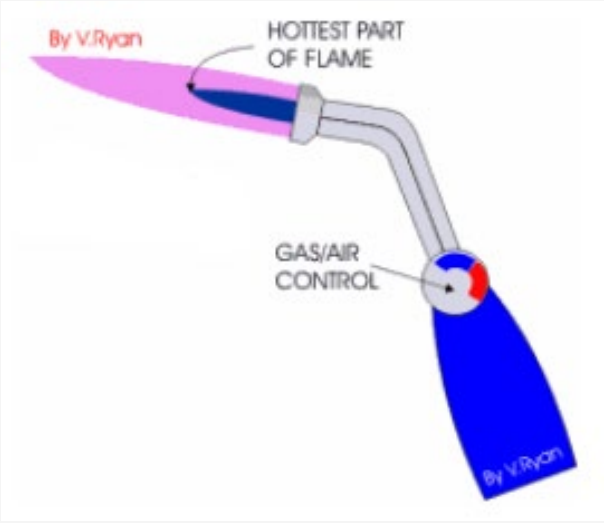


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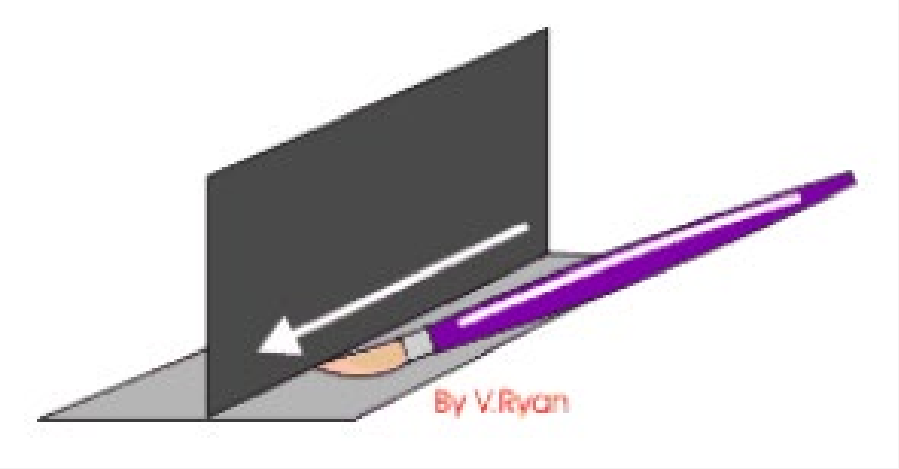
# BRAZING PREPARING THE STEEL



1. Two pieces of steel sheet are to be brazed. The steel must first be cleaned so that grease and dirt is removed. Wire wool or emery cloth are the most suitable abrasives.
A borax flux (powder) is mixed with water to produce a paste which is brushed along the joint. Flux prevents oxidation taking place on the metal surfaces as this would prevent brazing being successful.

**Tap the image** for more information and an exercise

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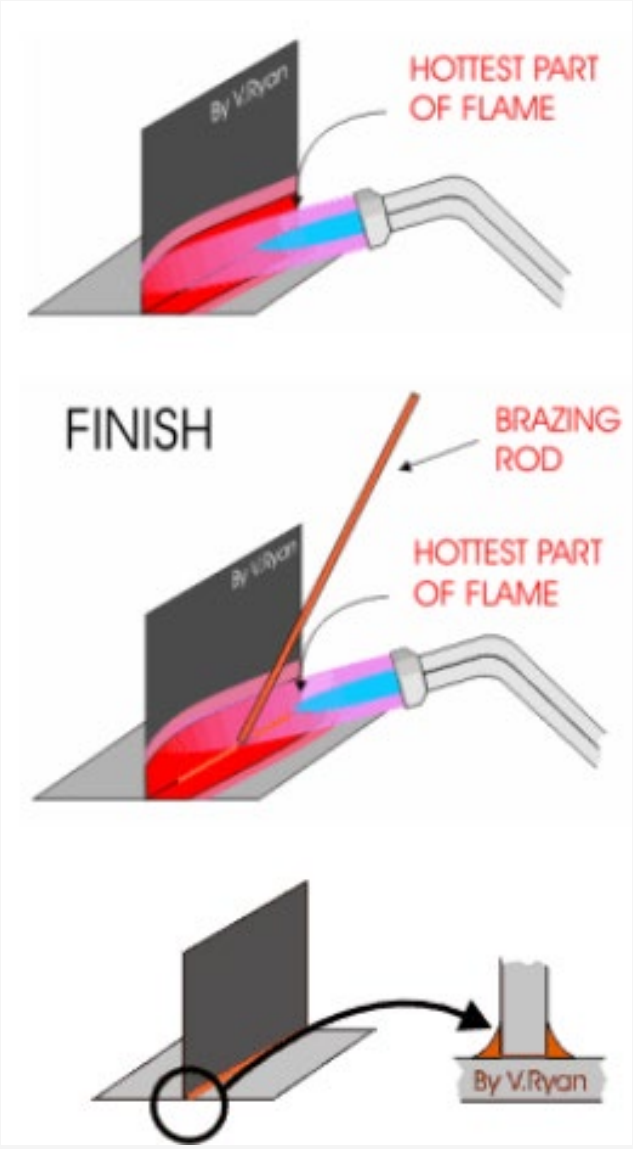
# BRAZING ON THE BRAZING HEARTH



**Tap the image** for a detailed explanation of brazing, on the brazing hearth.




The steel is heated on the brazing hearth, until the 'joint' area is bright red.
The brazing rod is then introduced to the joint. It melts and the molten 'rod' follows the joint line. When cool, it provides a permanent joint.

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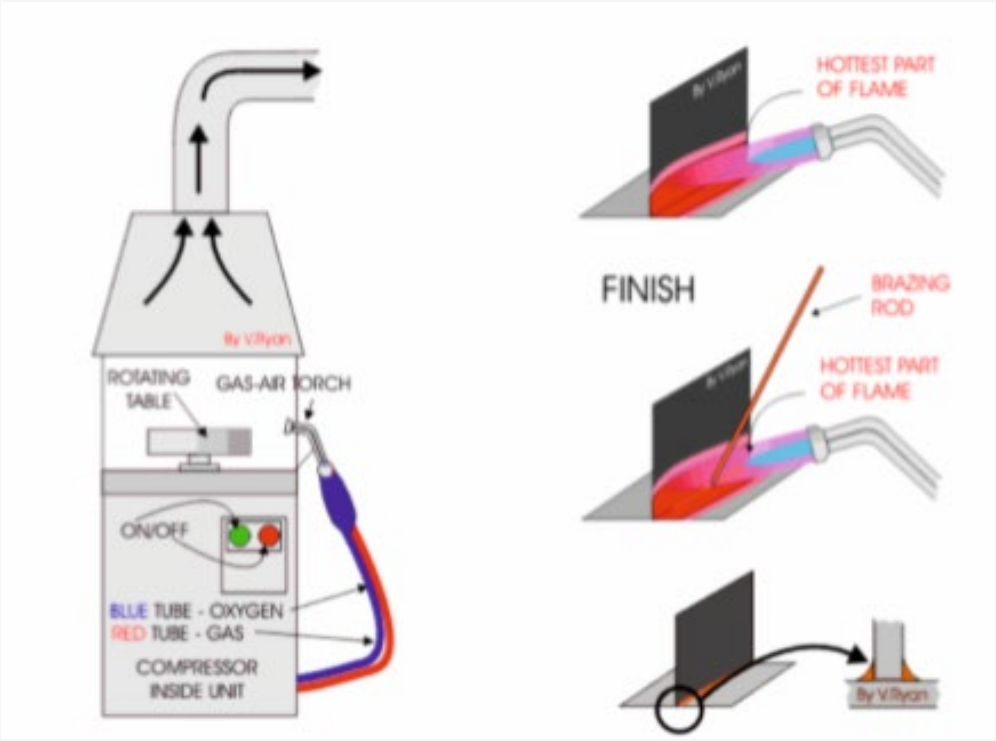
**Tap the image** for a Boxed Learning Exercise on Brazing

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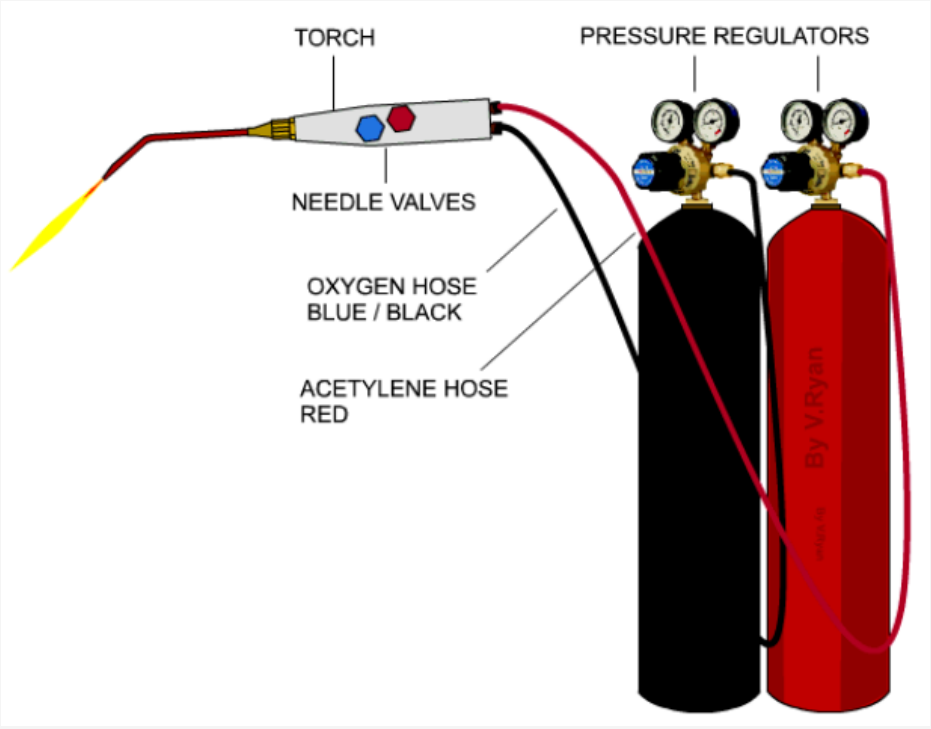
# GAS WELDING - OXYACETYLENE



Oxyacetylene gas welding, is used to permanently join mild steel. A mixture of oxygen and acetylene, burns as a focussed flame (3,500) degrees centigrade. When the flame comes in contact with steel, it melts the surface forming a molten pool, allowing welding to take place. Oxyacetylene can also be used for brazing, bronze welding, forging / shaping metal and cutting.

**Tap the image** for more information



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# GAS WELDING AND SAFETY



A leather apron and leather gloves are essential. Good ventilation is also essential. Special welding goggles protect the eyes from the potential 'splatter' of molten metal. They also protect the welders eyes from the dangerous ultraviolet and infrared light waves, produced by light emitted by the intense flame of the torch.

**Tap the image** for more information


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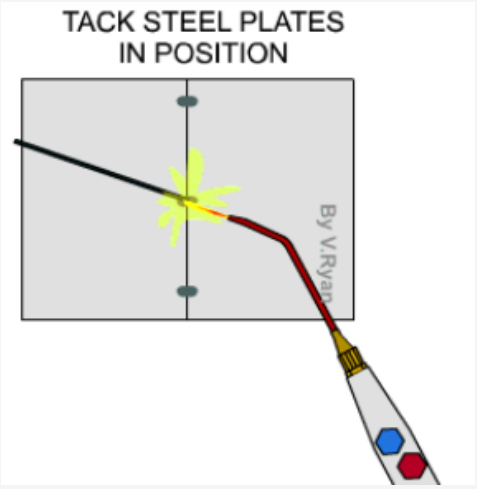
# BASIC GAS WELDING PROCEDURE

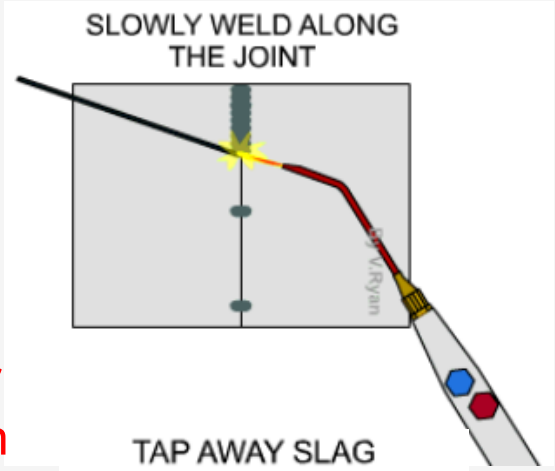


Tack the two steel plates together




**Tap the images** for detailed information and exercises

The entire joint is welded, slowly and accurately




**Tap the images** for detailed information and exercises

Tap away the 'slag' from the finished joint

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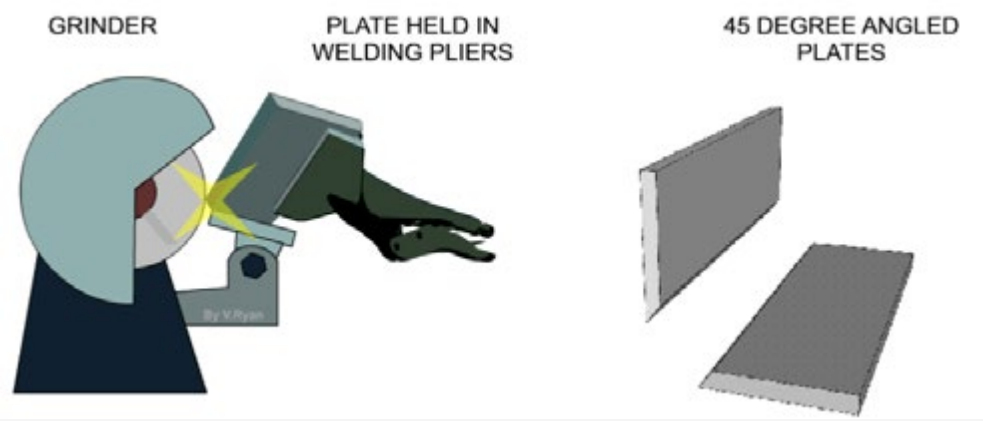
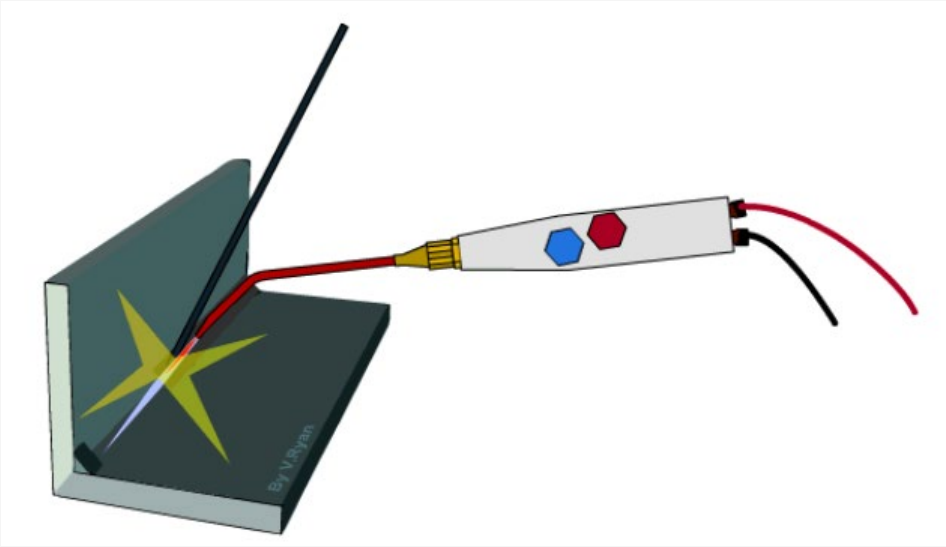
# WELDING STEEL PLATES AT RIGHT ANGLES



**Tap the images** for more information and exercises.



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# BRAZE WELDING



Oxyacetylene can be used to braze weld (bronze weld). The steel tube and steel plate have been heated to a dull red heat. The 'bronze' filler rod (coated with flux) is then introduced to the joint. It flows onto the two surfaces, forming a 'fillet' around the joint, joining the two surfaces.

Braze / bronze welding provides a strong joint and is ideal of steel frames, where a certain amount of flexibility is required.

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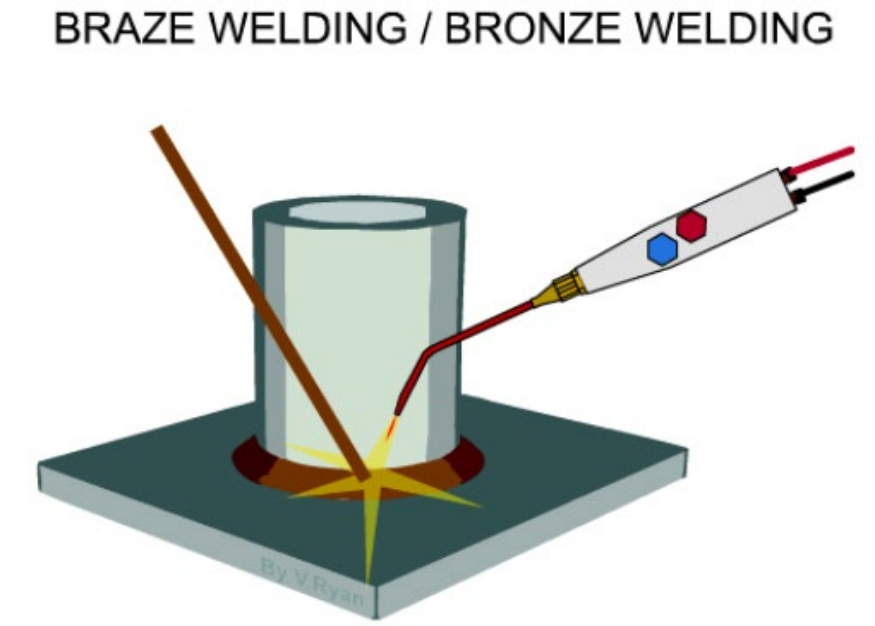


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# PRACTICAL APPLICATION OF BRAZING AND BAZE WELDING

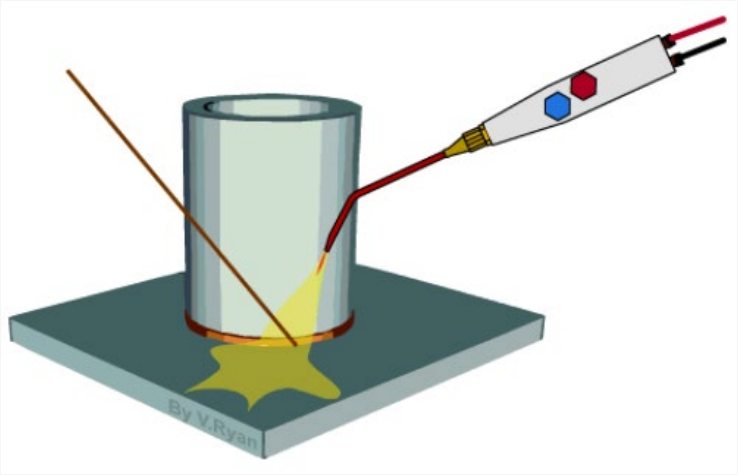


Brazing is ideal for manufacture of bicycle frames, as it does not 'fracture' as easily as steel welded joints.

Brazing and braze welding (bronze welding), can be used to join similar and also dissimilar metals such as:

Mild Steel - Galvanized Steel
Stainless Steel - Copper
Mild Steel - Stainless Steel
Stainless Steel - Copper-Nickel
Mild Steel - Cast Iron

**Tap the image** for more information

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# ELECTRIC ARC WELDING



Electric arc welding - the metal to be welded is clamped in the earthing /ground clamp. An electrode is gripped in the electrode holder. A suitable 'current' is selected by turning the current selector handwheel. When the electrode comes into contact with the metal, an 'electric arc' is formed, creating immense heat. At this point both the electrode and metal surface melt and fuse together, creating a weld.

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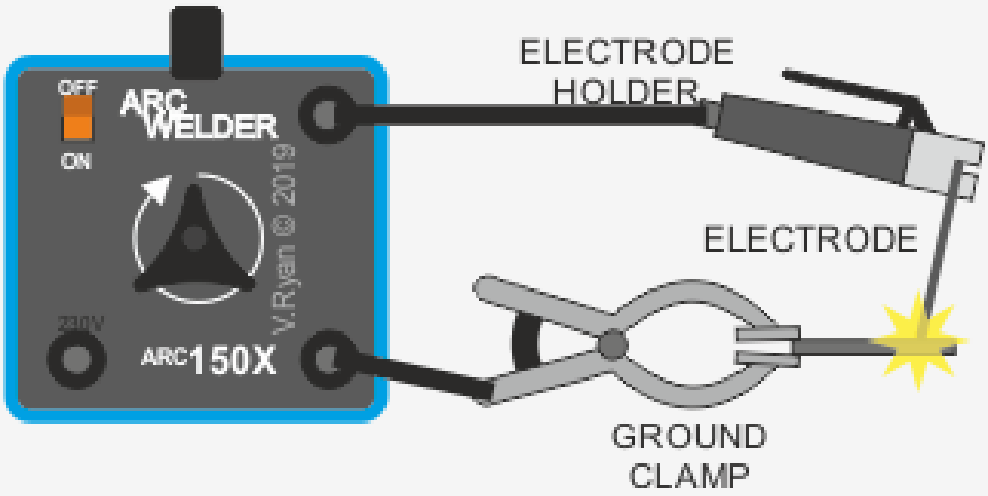


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# SPOT WELDING



Spot welding - used to join sheet metals. The metal sheets are placed between two copper electrodes. Current is passed through the metals via the electrodes, producing a 'localised' high temperature, causing the two sheets to fuse / weld together, at the point of contact. Advantage - welding is localised. Therefore, the rest of the material, does not suffer the effects of the high temperatures.

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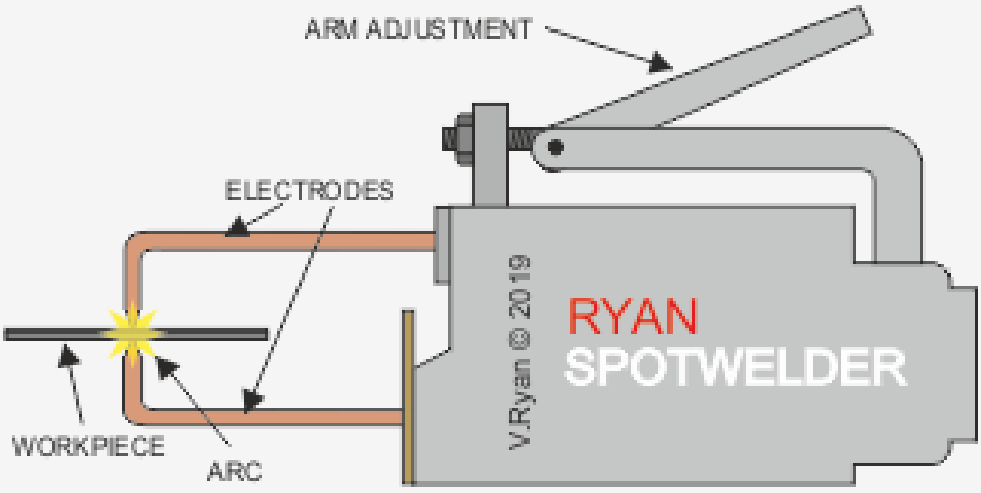


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# MIG WELDING (Metal Inert Gas)



The electrode is a continuous stream of wire, with a direct current source and fed through the welding gun. Carbon dioxide gas is supplied directly to the welding zone, protecting the area from atmospheric contaminants. The electrode, produces an 'arc', heating the welding area and fuses the wire electrode with the surface of the base metal (metal being welded).

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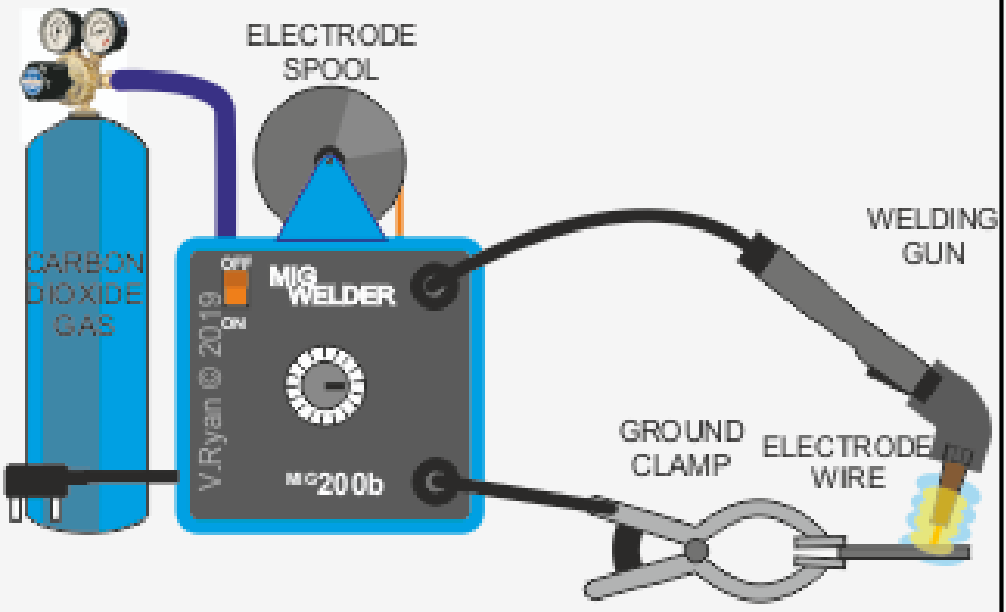


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# TIG WELDING (Tungsten Inert Gas)



TIG welding uses a non-consumable electrode, which produces the arc, creating the heat required to weld (melting and fusing the surface of the metals being joined). The electrode does not melt during the welding process. The filler rod is fed into the weld area by hand. The protecting gas is usually argon, which prevents contamination from gases in the air.

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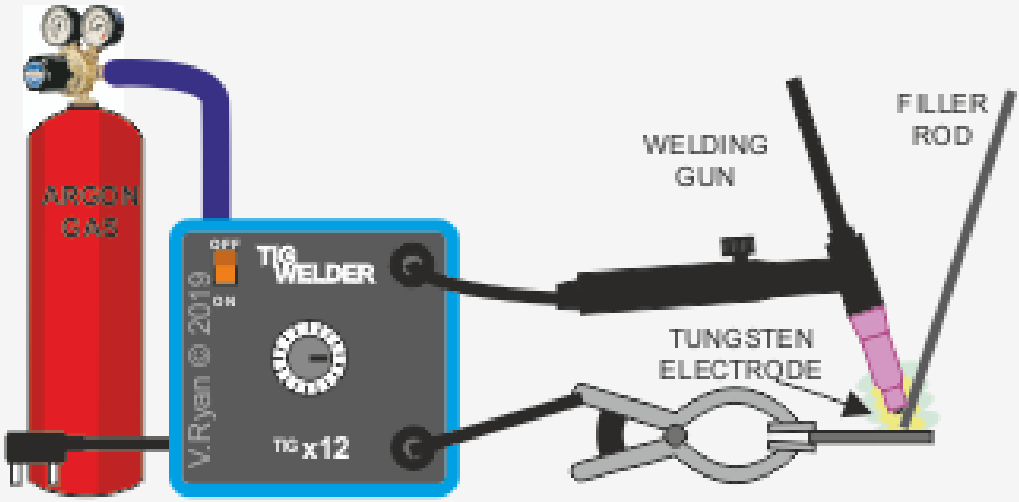


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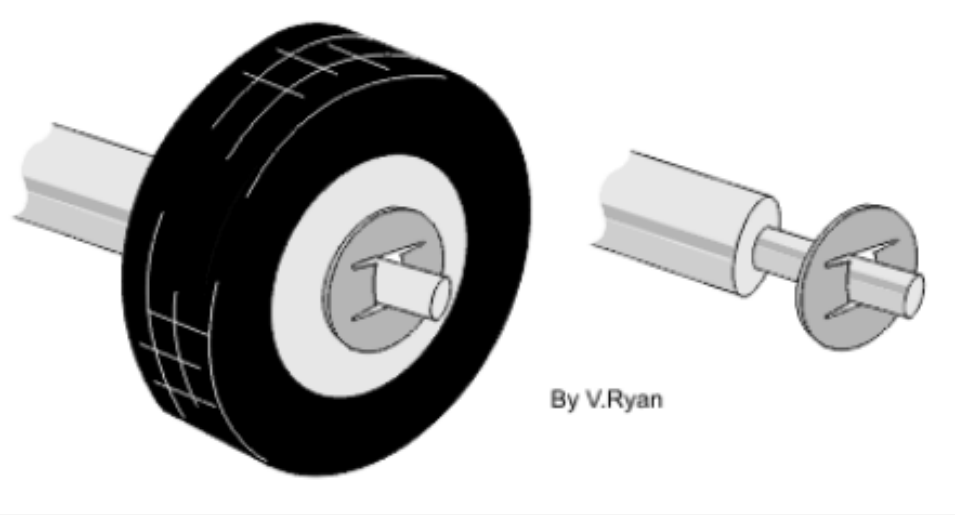
# PUSH FITTINGS



Push on fittings are very popular as they are simply pushed onto the steel / plastic shaft. They are made from hardened spring steel which makes them tough and flexible. They can only be pushed in one direction only (forwards). To remove them they must be forced backwards, this will damage them so that they cannot be used again. As they are very cheap and disposable, they can be replaced. They are suitable for light wheeled vehicles such as light trolleys.

**Tap the image** for more information and an exercise

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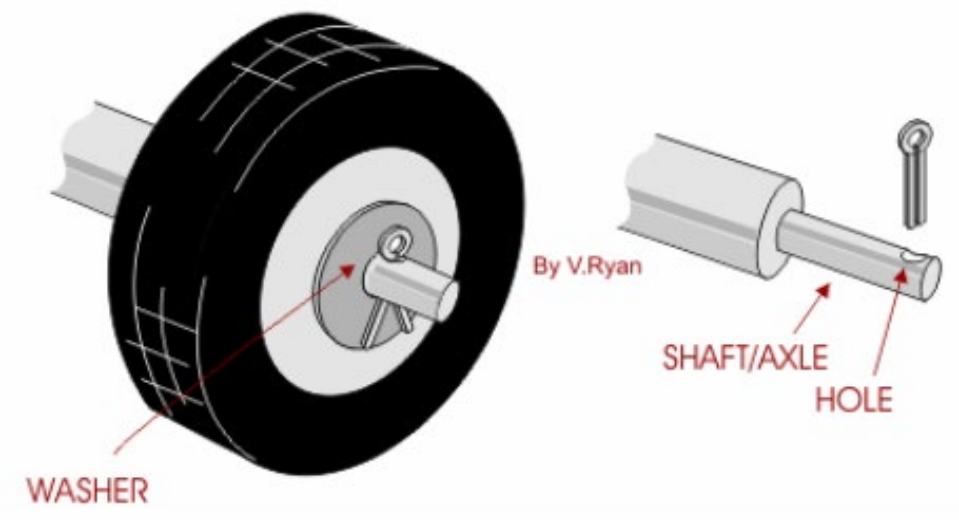
# SPLIT PINS



Split pins are very common as they are easy to use and effective. Often they are found on self-assembly trolleys, light wheel barrows, lawn mowers and similar items. They are usually made from 'soft' steel or aluminium and they come in a range of sizes.

**Tap the image** for more information and an exercise




Tap the blue button for the next JOINTS page.

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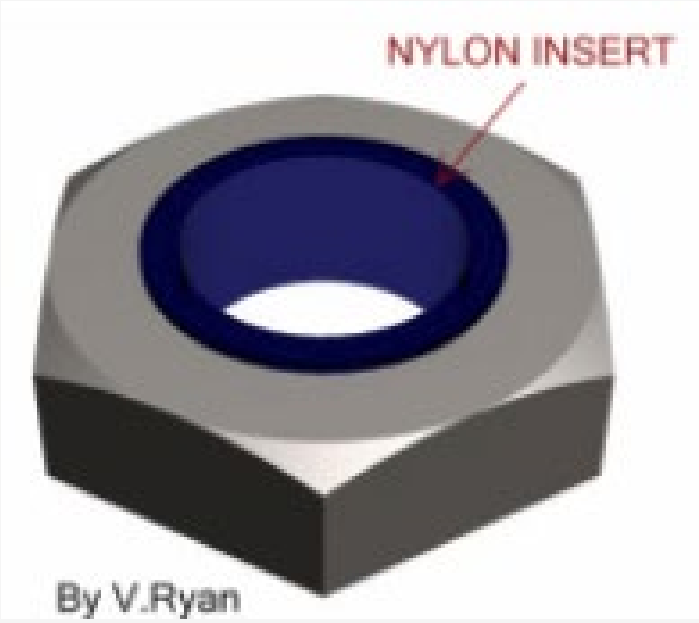
# LOCK NUTS



A close look at the lock nut shows that it has a nylon sleeve. As the nut is tightened, the thread on the shaft / axle cuts into the nylon, holding it firmly in position.
As the wheel rotates a normal nut will loosen because of friction and vibration of the wheel. However, the nylon holds the nut firmly in position.

**Tap the image** for more information and an exercise




Tap the blue button for the next JOINTS page.

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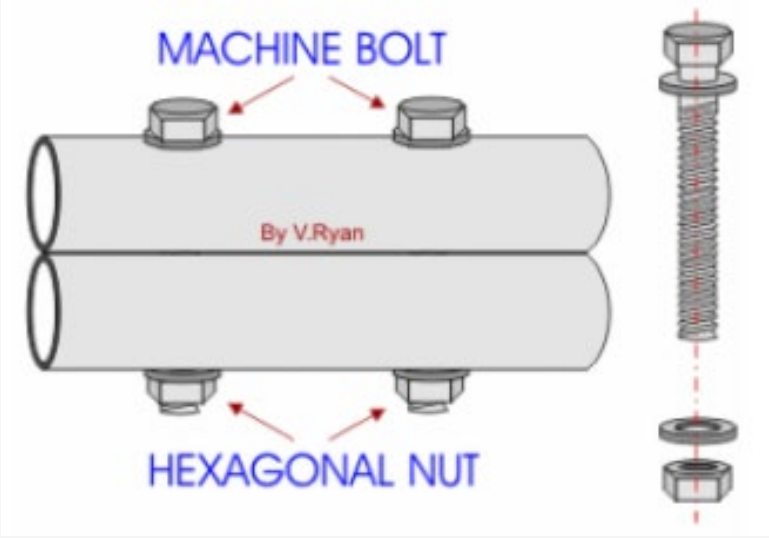
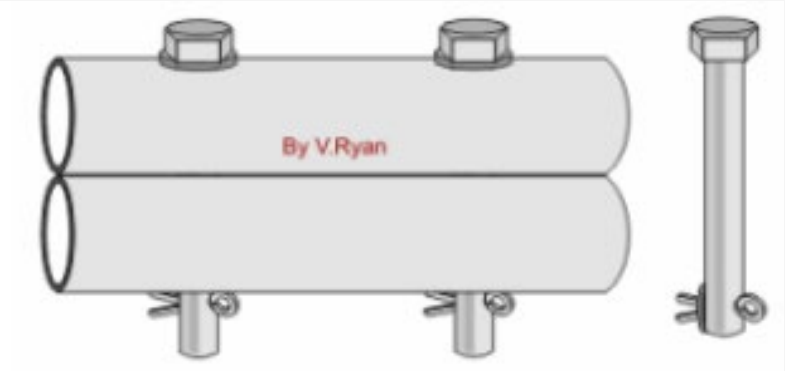
# USING NUTS AND BOLTS TO JOIN TUBE



**Tap the two images** for information and exercise on joining tubes using nuts and bolts

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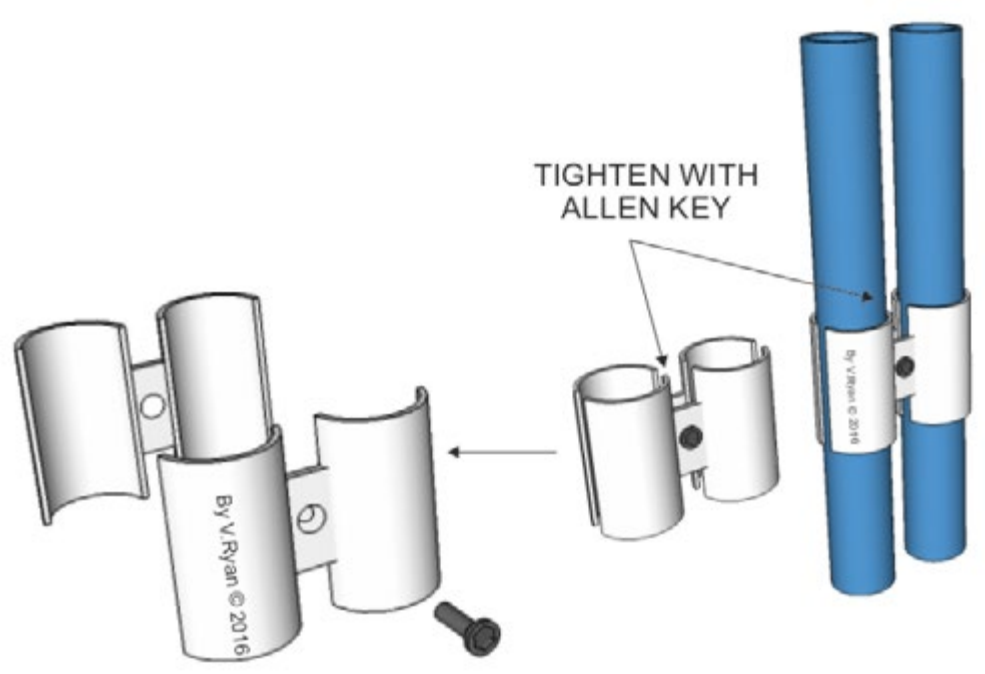
# PARALLEL JOINT.



The joint shown below, is for joining two tubes in parallel. The joint is in two halves and a single bolt is tightened using an allen key, fixing to two tubes together.

**Tap the image** for more information and an exercise

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# FOUR WAY JOINT



This joint allows four tubes to be fixed together. It is a friction fit, but if the tubes were threaded (had a screw thread) at the end, they would be extremely secure and could be regarded as permanent.

**Tap the image** for more information and an exercise

Tap the blue button for the next JOINTS page.

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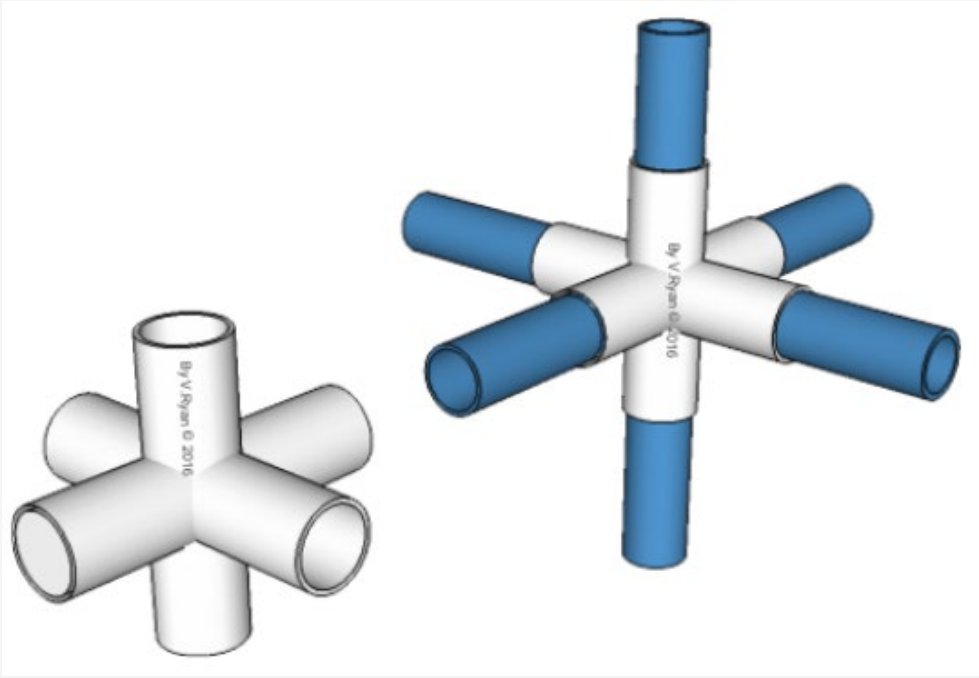
# SIX WAY JOINT



This allows up to six tubes to be jointed. A friction fit, but if the tube was threaded at each end (screw thread), this would be a very secure joint.

**Tap the image** for more information and an exercise



Tap the blue button for the next JOINTS page.

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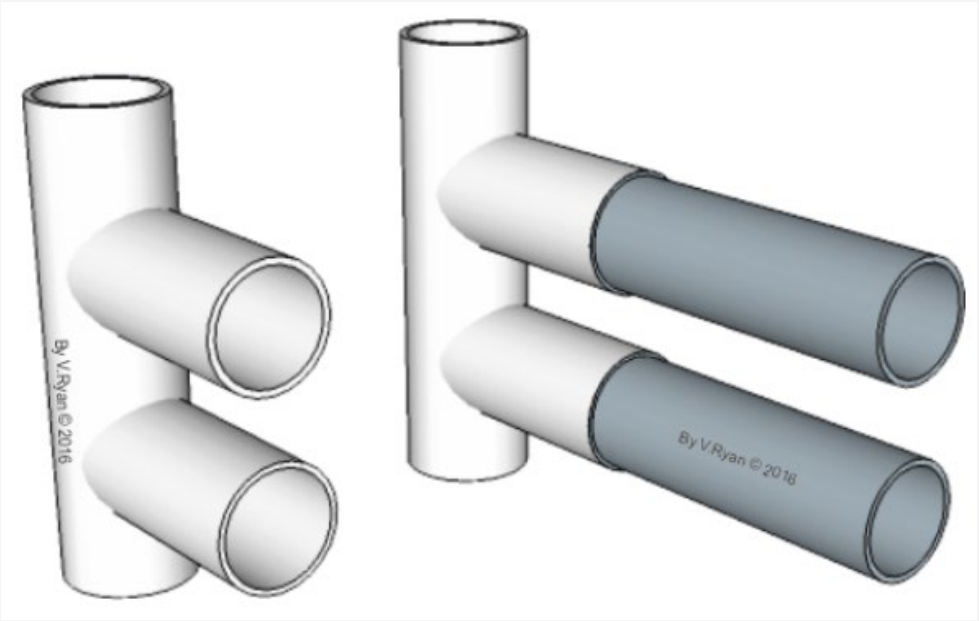
# TWO WAY PARALLEL JOINT



This allows two pieces of tube to be joined in parallel.

**Tap the image** for more information and an exercise

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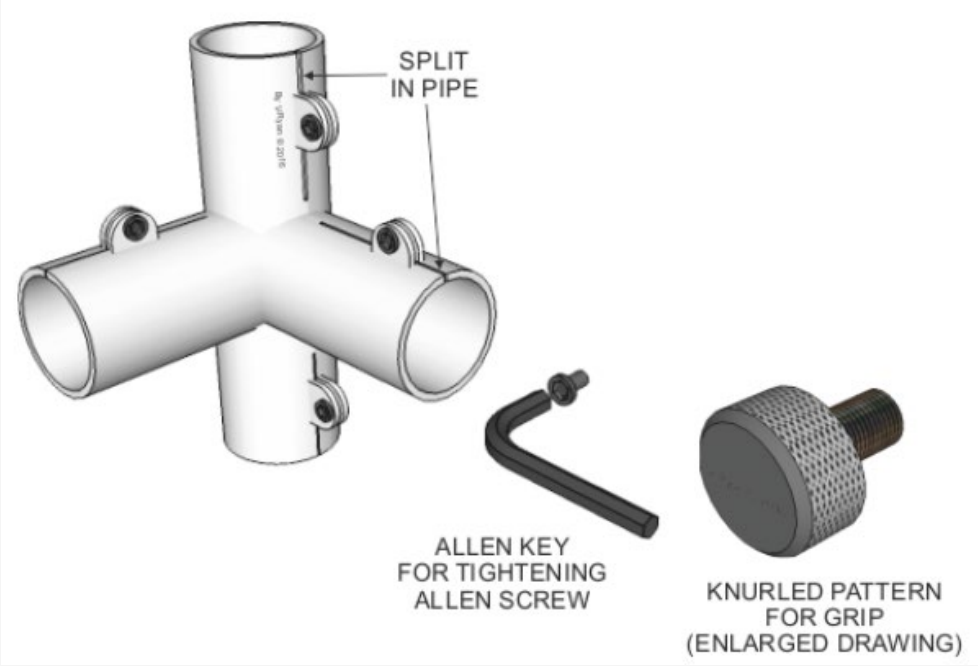
# SPLIT TUBE JOINTS



This four way joint can be adjusted / tightened with a allen key. As the allen key is turned, the split in the tube narrows, tightening on the tubes. The allen screw could be replaced with a screw that can be turned by hand, such as a wingnut or a 'knurled' pattern.

**Tap the image** for more information and an exercise

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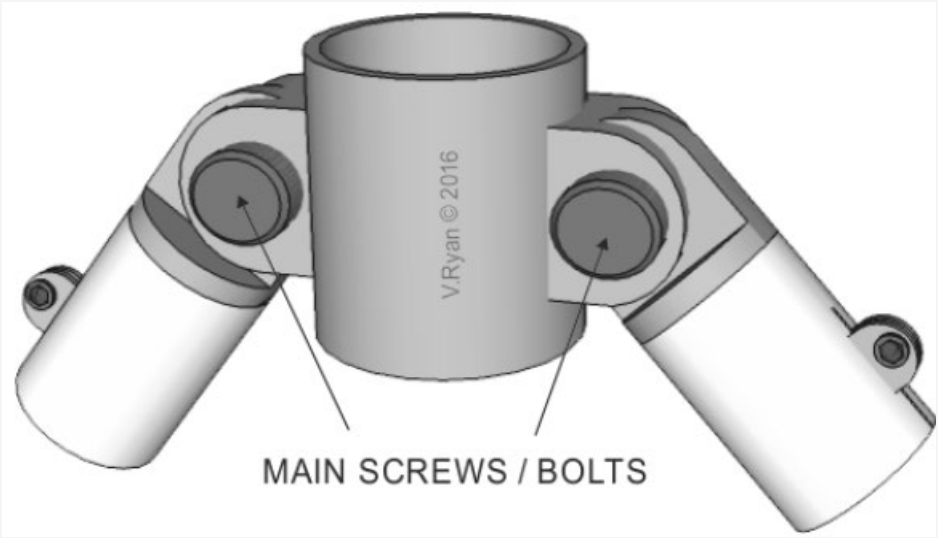
# ADJUSTABLE JOINT



Loosening the main screws / bolts, allow the tubes to be adjusted to the right position and then tightened.

**Tap the image** for more information and an exercise



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# WHAT IS PLASMA CUTTING?



Metals and alloys that conduct electricity, can be cut and shaped using a Plasma Cutter. This process is useful, when cutting stainless steel, aluminium, copper, brass, cast iron and mild steel.

One advantage of cutting and shaping using a plasma cutter, is that the metal is less likely to distort, as the heat that is generated, is localised to the cutting area.

**Tap the image** for more information and an exercise

Tap the blue button for the next JOINTS page.

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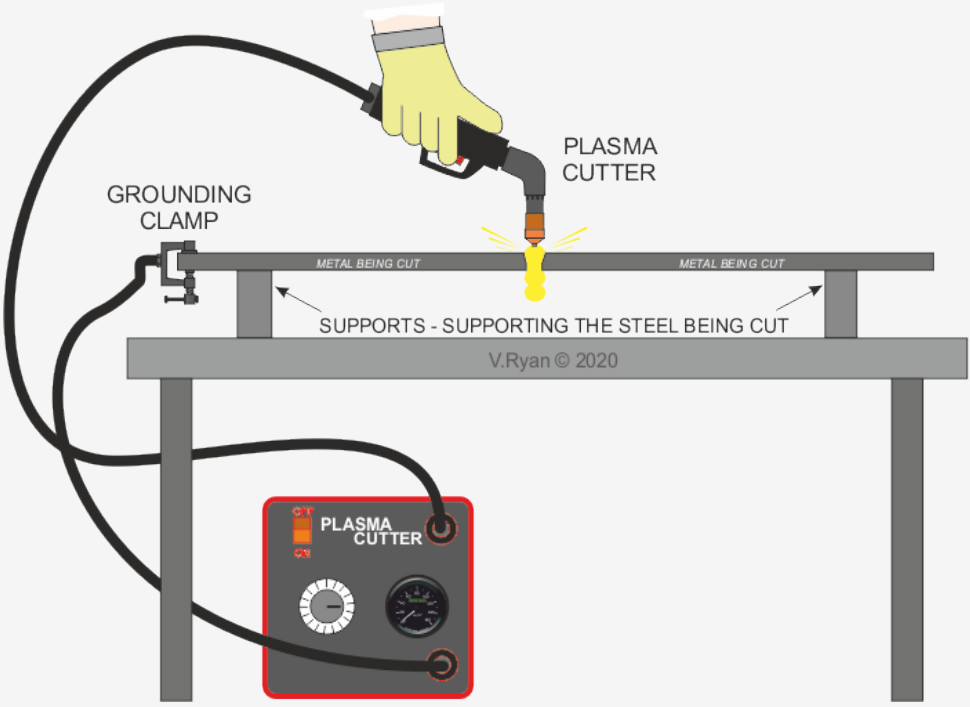
# PLASMA CUTTING - BASIC TECHNIQUES



When plasma cutting, the metal being cut, is set at a comfortable height (if possible). The metal is usually supported above the surface of a work bench, which has a heat resistant surface (such as fire bricks set into the table top or vermicular board).

**Tap the image** for more information and an exercise

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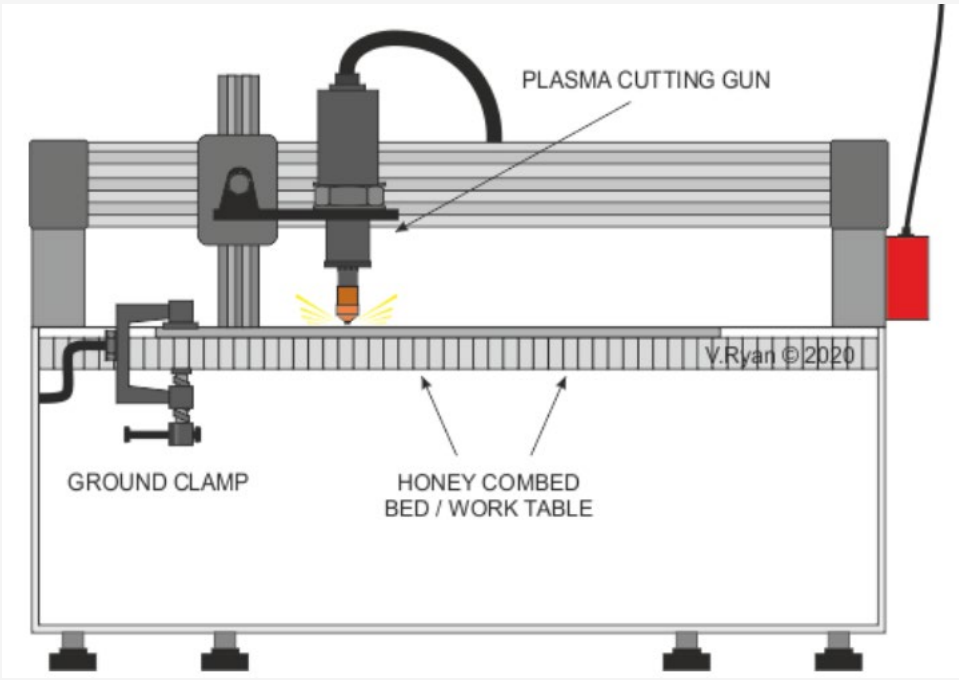
# LARGE SCALE COMMERCIAL PLASMA CUTTING



Large scale plasma cutting and shaping is usually computer controlled. The metal to be cut is placed on the honeycomb bed / work table. The design / shape to be cut, is composed using CAD software and exported as a dxf file. It is this file that guides / controls the plasma cutting gun.

**Tap the image** for more information and an exercise

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