

## Introduction to Arc Welding.

Arc welding takes some effort to learn, and it is very sensitive to the position of the work.

It's a good idea to keep things easy to begin with by laying beads on the flat. We'll cover joints later.

The following setup is a good starting point for this tutorial:

- **Work:** 6mm mild steel. Arc welding is more tolerant to slightly rusty metal and mill scale than other electric welding processes, but it is good practice to clean the worst off with a grinder before welding.
- **Rods:** 3.2mm 6013 rods. USE GOOD QUALITY RODS! A forum member trying to learn with DIY store rods had terrible trouble until someone sent him a few brand name rods to prove a point. Also 3.2mm rods are easier to learn with than 2.5mm rods.
- **Amps:** 110 amps. (If you want to use 2.5mm rods reduce the current to about 80 amps - the current is determined

more by the rod size than the thickness of sheet).

- **Polarity:** DCEP (rod positive, earth negative - this is the opposite of the polarity used in TIG). Use AC if that's all you have.

### Rod Angle (lead angle)

For welding on the flat (as in the photo) the rod should be angled 10 to 20 degrees from vertical and pulled in the direction of the arrow. The angle of the rod prevents the slag overtaking the rod (welding over slag would cause inclusions in the weld).

In the photograph the rod has been bent at the electrode holder to position the holder at a more comfortable angle.

It's OK to support the top of the electrode with your spare hand and this improves control of the electrode. Electric shocks aren't a problem, but be careful to reposition your hand away from the heat before the electrode gets too short.

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### Arc Length

The arc length is the distance between the electrode and the weld pool. It should be roughly the same as the diameter of the rod.

This is nowhere near as straightforward as it sounds!

The photo right shows how the electrode becomes recessed inside the flux covering on the rod. The weld pool will also be hidden by molten slag.

To achieve the correct arc length using 3.2mm rods the distance between the flux coating on the rod and the flux on top of the weld might be less than 1mm.

The arc length is normally judged by the sound and visible light from the arc.

In the video, you will be shown; the arc length is varied between correct, too long, and too short. Both the intensity of light and the sound of the weld alter dramatically with the length of the arc.

The arc should be kept short and hide the majority of the light from the weld without pushing the rod into the slag pool. A good short arc length will result in a consistent

sharp crackling sound.

The appearance of the completed weld will provide further clues - see photos of welds with incorrect arc length on the faults section

### Maintaining Lead Angle and Arc Length

The rod becomes shorter as the weld progresses, and it takes a **conscious effort** to reduce the length of the arc, as the rod gets shorter.

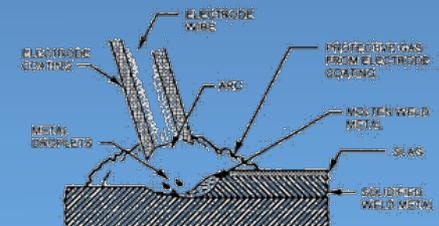
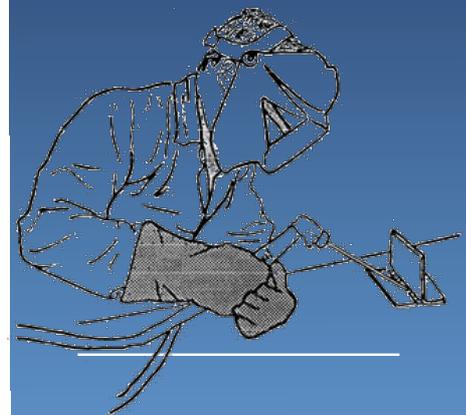
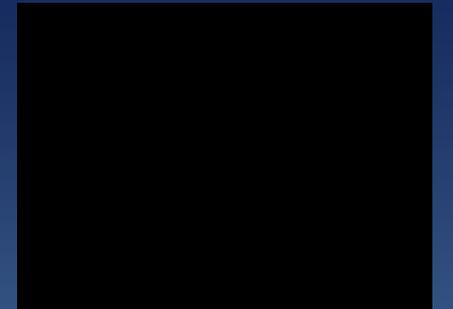
Excess arc length can lead to an unstable arc, excess heat and undercutting and is probably the most common beginner fault.

The angle of the rod should also be maintained over the length of the weld. A little practice is required to avoid decreasing the lead angle as the weld progresses, as this can result in slag inclusions and even cause the arc to stall.

The easy way to maintain rod angle is to focus attention on moving the rod holder rather than the rod as the weld progresses.

The video you will watch shows a 2.5mm rod being consumed while running a bead around 200mm long.

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### Welding Motion

For most arc welding the rod is moved in a straight line to form a "stringer". A tiny amount of weave can be used to help control speed and direction.

In the video you will see that the arc is started with a tap start. The rod quickly becomes shorter as the weld progresses and the motion that can be seen is constant correction to maintain a short arc length.

**Note** the rod angle is also maintained. It takes practice to maintain arc length and rod angle, especially if you are moving to arc welding from another welding process.

### Slag

Don't look closely at a hot weld - bits of slag continuously ping off the weld as it cools and it is very painful to have them removed after they've burned themselves into your eye. Eye protection is also a good idea when chipping slag, as it's brittle and can fly a fair distance.

The slag covering the weld should be reasonably easy to remove, though it does depend on the type and quality of rods (we were

using some good quality 6013 rods here so it was easy).

### Practice makes pads

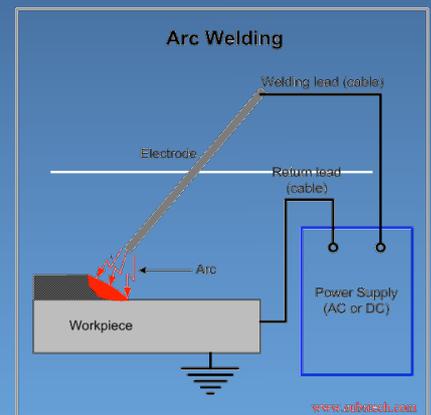
Other positions will go disappointingly badly before you have perfected laying beads. A good way to practice is to weld a pad on 6mm plate.

Clean the plate thoroughly, and then lay the first weld in a straight line near the edge of the plate. Remove the slag and lay a second weld immediately to the side of the first, close enough so the two welds merge together with no gap. Repeating several times should result in a pad of welds with a flat top. If you struggle maintaining a straight line then drawing a line in chalk might help.

Turn the pad 90 degrees and weld the next layer of the pad.

In college training the pad would be sectioned to check for inclusions in the weld. The practice helps develop consistency, keeping the weld in a straight line, and is good preparation for thicker metal where the joint is often formed from multiple strings of weld. The technique is also used for hard facing and building up worn material.

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### Starting the Arc

Arc welders don't have a button to start the arc. Unlike MIG welders the rod (electrode) will become live as soon as the machine is switched on.

The arc is started by touching the electrode momentarily against the work to complete the electrical circuit before raising the electrode to establish the arc.

This needs to happen quickly to avoid welding the rod to the work. "Tap starting" and "scratch starting" are the two common methods of starting the arc.

Because the rod is live at all times it needs to be kept insulated from the earth when not in use.

In the photo the welding bench is earthed, and a piece of wood is being used to isolate the rod from the bench. After welding the rod is returned to the piece of wood.

### Tap Starting

A sharp tap of the rod against the work will remove excess flux from the end of the rod and create the electrical contact needed to start the arc.

A sharp wrist action should allow a momentary contact with the work before quickly pulling the rod a short distance away. Too heavy a contact or too slow an action can cause the rod to stick.

In the video the auto-darkening helmet darkens as soon as the arc is started. The light is bright at first because the arc length is initially too long. The arc length is quickly reduced to the correct distance for welding.

Rods start much more easily on the second attempt. It is good practice to first start the arc on some scrap material before starting the arc at the beginning of a weld.

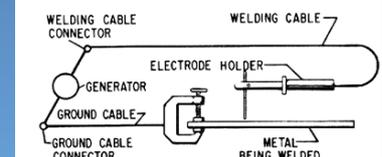
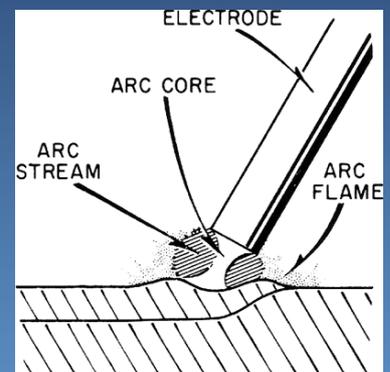
2.5Mb Flash video preloads before playing and includes sound.

### Scratch Starting

An alternative starting method is to lightly scratch the rod against the work. As soon as the rod starts to spark it is lifted from the work to start the arc.

In the video a backwards and forwards scratching motion is used to remove the flux coating. A limited movement should mean the arc will start somewhere close to where you want to start welding.

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When the first spark is seen the rod is pulled away from the work to prevent sticking, and then it is returned to the normal arc length for welding.

The scratch start technique is more prone to sticking as it relies on human reaction times. It can be a useful technique for difficult to start rods, or for AC machines and those with low open circuit voltage which make arc starting more difficult.

Excessive pressure on the rod while scratching will increase its chances of sticking.

### Rods Sticking to the Work

If you are new to arc welding you will frequently stick the rod to the work when trying to start the arc.

The rod welds itself to the work and it won't be possible to remove it just by pulling. Moving the rod backwards and forwards, or twisting the rod should fatigue the joint allowing you to remove the rod. If you have a crocodile clip type electrode holder you can just release the rod from the holder.

There's no need to panic when the rod sticks. It's normal for rods to stick occasionally, so arc welders are designed to cope with it for a short time. Inverter welders will reduce voltage automatically, and transformer welders should only go up in smoke if the rod is stuck for a prolonged period.

For interest, the photo shows the electrode of a 7018-rod recessed into the flux coating after welding - it illustrates why the flux coating needs to be removed before the arc will start.

A tip to make starting much easier

Keep some scrap material near the work and start the rod on that before beginning your weld. This will remove excess flux and warm up the rod, which will make it much easier to start your weld.



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### Arc Welding Machines and basic setup