# EPAG RoadRunner buys a new toy:

***Prequel:***
*There are obviously Forum members more qualified than me to write an article on TIG welding. This article is written from a beginner's point of view, is intended for beginners and is as accurate as I can make it based on my own learning experience.*

**A Beginners Guide to TIG Welding:**
Well I mentioned recently on the Forum that Ade Colmar should be a 'Salesman' for 'R Tech' and now I'm convinced of it as after the exchange of several PM's and a bit of procrastination (on my part), he convinced me to buy one of their TIG welders.

The procrastination bit came about because when I approached my friend Adrian (a Director at a local metal fabrication company), hoping he could get me some discount on a TIG machine, he persuaded me that a MIG welder would be better for my needs as it would be quicker, easier and use less gas. At the time I decided not to buy a MIG as my son told me he would lend me his; unfortunately he lives 120 miles away so it cannot be collected until after lockdown.

In the event I was eager to make a start on my chassis and could not get the idea of a new TIG out of my mind. Some 3-weeks after advising Ade his salesmanship technique had failed I succumbed to my urge to have a new toy and bought one.

**Note.**
*I'm not really worried about TIG taking a little longer than MIG, or that it's slightly more expensive; what clinched the choice of TIG for me is the type of future electric welding I'm likely to do as a hobbyist.*

When my new toy arrived I looked at the box and thought "the TIG welders I've previously seen were four times as big as this box!" Opening the box was an even bigger surprise as the welding machine only took up half the box. As soon as I opened it I realised the problem "they had sent me a desktop computer tower instead of a welder" however a closer inspection revealed several holes into which I could plug the various bits and pieces that occupied the other half of the box.


**My new computer.**

Reading through the manual revealed that it was written in a foreign language and contained a lot of new words, or groups of words, such as Pulse Frequency, Upslope, Downslope, Arc Force and Pulse Width. Surfing the Internet revealed that there was plenty of stuff on 'U-Tube' about TIG welding and in particular there were two videos covering my actual machine, unfortunately due to a combination of the demonstrators regional accent and my partial deafness (or should I say 'challenged hearing' in these politically correct times?), everything was clear as mud.

Returning to the box and the instruction booklet I discovered that I needed a few more items before I could get started, namely; a welding mask, gloves, welding wire and a 13-amp plug. Further correspondence with Ade resulted in the recommendation that I buy a flow meter** to save on gas so one was quickly ordered. When the mask arrived I found it to be very uncomfortable on the top of the head and as a result I ended up buying a welders hat that is worn under the mask; it also protects the back of your head and neck from flash if other people are welding in the vicinity.

**Note.**
*** Hindsight is a wonderful thing and a flow meter is absolutely essential as setting an accurate flow rate using just the gas regulator tap is impractical. I have written to R Tech stating that the flow meter should be included in the basic kit.*

Having had previous dealings with BOC and their expensive bottle rental I bought a gas cylinder from 'Hobbyweld'. It cost £110 outright purchase for the 20 litre bottle, which is supposed to give approximately six hours of welding time. Filling it up with pure Argon cost another £114. I can keep the bottle as long as I need it and exchange it for a refilled bottle at any time (for another £114). If and when I no longer need it they will buy the bottle back for £100. That equates to a lifetime bottle rental for £10.

TIG welding is something I've never ever tried and I decided I needed a bit of practise before starting to weld Pegasus's chassis as I don't want it to snap in half as I go over a humpback bridge. For practise I decided to make a welding trolley.

Looking at the TIG trolleys on eBay etc. to get some ideas for design I rejected them, mainly because the trolleys were over complicated and top heavy. This led to further surfing on the internet to look at homemade trolleys, which again were rejected, but I did discover that a company just 57 miles away offered a free 4-hour basic TIG welding course for purchasers of new R Tech welding machines, and it gave a code to put on your purchase invoice. Of course I'd already purchased my machine but ever hopeful I sent an email off to R Tech asking if I was eligible for the free course. They replied that I was. Actually it was a bit of a con as the course wasn't free and you had to pay a £0.01 administration fee (greedy bast*rds!).

Before getting into more detail with TIG let's have a quick recap on the three common methods of welding that I have previously used, the first two of which are carried out with the use of the dominant hand only, which offers the advantage that the spare hand can support the dominant hand, or hold a fag if that's your inclination.

**Electric Arc Welding: -** A sacrificial powder coated electrode is applied to the work and an electric arc is struck. As the arc intensifies the metal melts, a weld pool is formed and the work and bits that melt off the electrode fuse together and form the weld bead. As the powder on the electrode melts it forms a slag on top of the weld bead which excludes oxygen and thus prevents oxidisation. Electric arc is better suited for thicker material.

**MIG (Metal Inert Gas) Welding: -** When the torch trigger is pressed a sacrificial wire is fed through the centre of the 'torch/gun'. This wire acts as the electrode and completes the arc; it is also the filler wire. An inert gas is also fed through the torch and this gas displaces oxygen in the weld

pool area and prevents oxidisation. MIG is suitable for thin and thick-ish materials although additional passes may be needed on the latter.

**Oxy/acetylene Welding: -** Acetylene is used to provide the flame and oxygen to provide the heat. The dominant hand wields the torch and maintains the weld pool, as the torch progresses the other hand is used to apply the filler rod to the weld pool to complete the weld bead. It is important to maintain the weld pool by melting the two parts to be joined before adding the filler rod; a beginner's common mistake is to melt the filler rod onto the surface of the work without adequate penetration.

**Note.**
*Personally I have always been a fan of oxy/acetylene welding as it is very good on thin material plus you can; anneal, harden and temper, braze, silver solder, weld aluminium and hard solder radiators etc. Also the cutting and heating ability is very useful for dismantling rusty components; the downside can include heat distortion, overall cost** and a greater fire risk. Electric arc is useful on thicker material but removing the slag can sometimes be a pain and unless electrodes are kept under ideal conditions they normally have a limited shelf life. MIG is fairly easy and is probably the most common and easiest type of welding for the hobbyist to learn, but it does take experience to make it look neat. In my opinion a lot of MIG welding looks like a rabbit has hopped along the seam having a crap!*

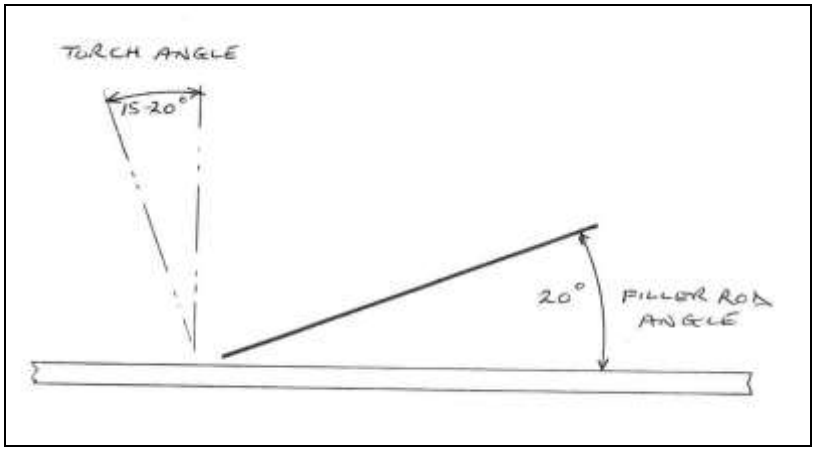
** *It should be noted that with more readily available supplies of 'outright purchase gas cylinders' from people like Hobbyweld, the use of oxy/acetylene welding and cutting kit becomes much more viable. The next time I need gas bottles for my oxy/acetylene kit I will buy them from Hobbyweld "No more expensive BOC bottle rental for me!"*

**TIG (Tungsten Inert Gas) Welding:**
This is totally different from other forms of electric welding. The main difference being that the electrode is **NOT** sacrificial. The Tungsten electrode is used to initiate and maintain the arc which melts the metal and forms the weld pool, the other hand feeds in the filler wire in a manner similar to oxy/acetylene welding.

So is TIG welding hard? Prior to purchasing my new toy I had never tried TIG welding and one things for sure it's different from the other types of welding I've tried; I would describe it as a cross between electric arc (commonly known as 'stick'), and oxy/acetylene welding.

Whilst TIG is often described as being the hardest welding method to learn like most things in life 'practise makes perfect', well maybe not perfect but it certainly makes an improvement. Before I started with TIG I thought that my oxy/acetylene experience would make TIG a bit easier to learn and I suppose in a way it did, but there are quite a few differences.

One major difference is with the use of the dominant hand (the one that holds the torch or gun), with oxy/acetylene you get used to moving it slightly away from the work to control the heat and the weld pool; With TIG the main task of the dominant hand is to maintain accurate positioning of the angle and distance between the tip of the electrode and the weld pool, too far away the arc is broken and the gas disperses and everything comes to a dead stop, it is also accompanied by a bright yellow flare which destroys your vision for a few seconds. Too close and the electrode touches the weld pool and develops a ball of molten metal on the tip and has to be re-ground. The use of the hand that holds the filler wire is very similar to that employed with oxy/acetylene welding.




**The correct angles for TIG welding.**

**Note.**
*In the sketch we are looking towards a right handed person welding from the right to the left.*

*To start the arc the torch is essentially vertical, once the arc is established the torch is angled at approximately15 to 20 degrees from the vertical.*

*The filler rod is held at approximately 20 degrees.*

*The distance from the tip of the Tungsten electrode to the weld pool is approximately 1 to 1.5 times the diameter of the Tungsten. So for my 2.4mm Tungsten I try and maintain a distance of approximately 3.5mm or just over 1/8".*

Like many craft skills much of it comes down to setting up the equipment (e.g. if you take over a paint spray gun that has been set up by a professional you will be surprised how well you can paint!), so let's deal with some control aspects and common terms that are used in the TIG set-up and how they relate with TIG welding using my machine a 'R Tech TIG160PD'.

**Power LED: -** Illuminates when the machine is switched on.

**LED Display: -** Displays main amperage when welding and relevant information when scrolling through the various settings.

**Warning LED's: -** when you turn the machine on both a green and amber light come on and the machine (computer?) then carries out a self diagnostic test. If ok the amber light goes out and the green power LED light stays on.

**Memory Store: -** You can store up to 9 job settings into memory.

**To Select Functions: -** Press Up or Down arrow buttons to scroll through functions.

**Selector Knob: -** Turn to adjust function settings, after a few seconds the display reverts to 'Amps'.

**MMA (Manual Metal Arc or 'Stick') Settings: -** Use this to set:
• Arc Force from 0 to 100%.
• Hot Start Time from 0.1 to 1.5 seconds.
• Hot Start Amps from 1 to 100 amps.

**Amperage (Main Current): -** More amps equals more heat! Too many amps makes a bigger weld pool and can burn holes in the material. Too few doesn't heat the metal enough to form a good weld pool. Thicker metal requires a higher amperage. It is often recommended that for an initial TIG setting you apply 1 amp for each thou (0.001"), of material thickness: i.e. for 1/8" (0.125"),** material thickness, which is what I am using on my new ladder chassis, we would set 125 amps on the machine. However 125 amps is only a starting point and I found out later that my machine operates satisfactorily at a much lower amperage (around 75% of the figure derived from the above formula). With the correct amperage you should be able to maintain a 5mm weld pool in one place without burning a hole in the metal.

**Note.**
*** This formula is also used to determine the approximate capacity of a TIG welder; i.e. my 160 amp machine will weld approximately 160 thou (0.16" or 4.064mm), but would require multiple passes to weld the thicker stuff; or alternatively you could use the 'Stick' function.*

**Gas Flow Rate: -** You need enough gas (normally pure Argon), to preclude the oxygen from the weld pool. Part of this is controlled by the gas flow pressure and part by the size/shape of the ceramic shroud that directs the gas as it leaves the torch. A recommended standard flow rate setting is 8 to 12 litres per minute of gas.**

**Note.**
*** Argon has an expansion ratio of around 1:840 i.e. 1 litre of liquid Argon produces approximately 840 Litres of gas.*

**Up-Slope: -** Is the time taken for the current to rise from minimum amperage to the selected weld amperage; on my machine it is adjustable from 0 to 5 seconds.

**Down-Slope: -** Is the time taken for the current to decrease from the maximum amperage set to zero amps; on my machine it is adjustable from 0 to 5 seconds.

**TIG Mode switch with Pulse: -** Sets machine to TIG with Pulse on.

**TIG Mode Switch without Pulse: -** (Standard TIG Mode), sets to TIG with Pulse off.

**Stick: -** Set to this mode when using the machine for normal arc welding with a sacrificial powder coated electrode. The additional cable and electrode holder is part of the standard kit that comes with the machine.

**Pulse Frequency: -** My machine has an inbuilt device that alters the main current so that it is intermittent; i.e. it 'Pulses'. The Pulse Frequency is how often the amperage changes in a second; e.g. if set at 25 it will flip between high and low amperage 25 times a second. One claimed advantage is that it is easier to weld thinner materials without burning holes.** It is also claimed that a pulse frequency of below 3 or over thirty is easier on the eyes. If you look at a good weld bead it looks like a stack of pennies that have been toppled on their sides to form an overlapping row. A high pulse setting will result in more 'pennies' per inch of weld bead. Pulse Frequency depends on the job but you can weld pretty well without it.

**Note.**
*** Other advantages of welding with a pulse setting include; better penetration, easier welding, beads that are aesthetically more appealing and the ability to go back over* rough welds to re-melt them and improve their looks; the welding machine also runs cooler.

**Pulse Width: -** This is the percentage time the current stays on the high side of the pulse. A setting of 30 to 50% is generally recommended.

**2 and 4 Way Selector Switch - 2T and 4T (2T/4T): -** In **2T** mode you press and release the trigger to start and stop the arc. In **4T** mode you press then release the trigger to start and then press and release the trigger again to stop; this means you don't have to keep the trigger depressed when doing long weld beads.

**Note.**
*I found the **2T** setting to be more natural.*

**TIG Starting Control HF Mode: -** in this mode the arc is started automatically when the trigger is pressed without the electrode touching the workpiece.

**TIG Starting Control Lift Mode: -** in this mode the arc is started by touching the electrode to the workpiece. This mode is used when carrying out welding on vehicles with sensitive electronics.

**Note.**
*I found HF mode to be easier.*

**Pre-Flow Gas: -** The range is 0 to 10 seconds and is the amount of time the gas will flow before the arc is started. A setting of around 0.5 seconds is suitable for most jobs.

**Post Flow Gas: -** The range is 0 to 25 seconds, you set the time the gas keeps flowing to cool and prevent contamination of the electrode after the weld has finished.

**Start Amps: -** (applicable to **4T** mode). This allows you to set the start current when the trigger is pressed, when you release the trigger the amperage will revert to your initial amperage setting.

**Tungsten Electrode Size: -** Tungsten electrodes are available in the following sizes. The minimum settings recommended by R Tech for the various electrode sizes are:
• 1.0mm electrode 5 amps.
• 1.6mm electrode 15 amps.
• 2.4mm electrode 30 amps.
• 3.2mm electrode 50 amps.

**End Amps: -** When in TIG mode with **4T** operation set this will adjust the final amperage from the time you press the trigger/button to start the stop sequence until you release the button. This enables you to make a better finish at the end of a weld bead.

**Modus Operandi for TIG Welding:**
The sequence is.
1. Set up the material/parts/components etc. for welding.
2. Connect the earth circuit, either to a metal workbench or directly to the workpiece.
3. Take common sense safety precautions; e.g. put up some shielding if necessary, keep pets away and tell the wife, kids and visitors etc. to keep their beaks out.
4. Put on your safety gear.
5. Switch on the machine and set all the electrical parameters.
6. Switch on the gas and set the flow rate.
7. Strike the arc and make machine changes/adjustments as necessary.
8. Add filler wire as necessary.
9. When finished switch of gas and electric and mark the job as hot if inquisitive people are around.

**My One Pence Course:**
Once I received my course booking code number from R Tech the booking of the course was done via the Internet with 'The Machine Shop' (Hinckley Leicestershire), in less than 5 minutes. After selecting a course date I entered my name and email address before filling in the box titled 'what did I want to achieve'. I put down that I wanted to learn how to best adjust the machine and to spend the rest of the time practising all the different joints.

The next and last box asked if I wanted to bring and use my own welder and I answered 'No'. "I'm fanatical (well perhaps a bit anal), about looking after things and many of my well used machines and tools look almost brand new, get my new welder dirty? No way, that's why I'm making a trolley, so it doesn't get scratched!"

At one penny for 4-hours the course was excellent value for money, especially as Robert, my instructor, declined the penny offered. It would still have been good value if I had to pay the normal £80 charge. It was one to one tuition with 5 minutes of theory, a few minutes dry run and the rest of the time was spent on practical. As a bonus everything is provided although I did take my own gloves and mask, plus some off-cuts from my ladder chassis box section; it made sense to have a bit of practise on the metal I will be using

I certainly benefited tremendously from this course and based on previous experience with craft courses I picked the instructors brains something wicked; learning what attributes signalled an adjustment change and filling several pages of my notebook with general information.

Although this course is of relatively short duration I believe that even a virgin welder would achieve a very good grasp of the basics. From the outset Robert said that stainless was easier to weld than mild steel which was why we practised with the hard stuff, although I did have a little go on the stainless.

I spent the four hours course duration (from 1400hrs to 1800hrs), working under Robert's instruction; he had told me earlier that he was there until 2100hrs and I could stay until then at no extra charge. The course was generally as per the following format.
1. Practice by laying a bead on flat metal strip. I did approximately 40 inches of this in two to three inch long beads.
2. Joining two pieces of flat strip by welding an external corner joint. (Approximately 20 inches).
3. Butt joints. (Approximately 10 inches).
4. 'Tee' or fillet joints. (Approximately 20 inches).

**Note.**
*I found the 'Tee' joints to be the hardest.*

At the end of the course I elected to spend some time practising on my chassis off-cuts and finished just before 1900hrs. After Robert inspected my chassis parts he declared my welding good and strong enough for my intended use, I was pleased to hear that but I wasn't entirely happy and decided to practise some more at home to achieve a better appearance. The photo below shows my final test piece that met with Robert's approval.

**Notes.**
*Not bad according to Robert but in my mind not quite up to snuff.*

*When welding 'T' joints in one pass you move the torch around in what is best described as a figure 8 pattern: although this results in a strong joint it can blur the stacked pennies effect.*

**Tips from Robert:**
Robert was very helpful and answered all my questions and there were too many to go into all of them in this beginners guide, however the following main points/advice are particularly relevant.

1. Don't adjust the gas flow with the knob on the gas flow meter. His advice was to turn that knob fully open, open the main bottle tap and adjust for a gas flow of 9 litres per minute with the main gas regulator knob by the gauges.
2. A #7 ceramic gas shroud is pretty versatile for most jobs.
3. A 2.4mm Tungsten (electrode) is suitable for most jobs.
4. Practise with amperage on different material thicknesses and note the setting to give a 5mm wide weld pool. This is your starting point. If you want a wider pool turn the amperage up; turn it down for a narrower pool.
5. A recommended starting amperage for my 1" x 2" x 1/8" thick chassis box section is 90 amps.
6. Select setting #9 on the welding helmet control and adjust to make it darker as necessary. The higher the amperage the darker it should be set.
7. 1.6mm filler wire is the most useful for mild steel.
8. 1.0mm filler wire is the most useful for stainless steel.
9. Set pre-flow gas at 0.3 seconds (I'll stick with 0.5 seconds).
10. 1Set post-flow gas at 5 seconds. (R Tech recommends 8 seconds).
11. Set up-slope at 0.2.
12. Set down-slope at 0.3.
13. Set end amps at 10.
14. If you are doing ornamental welding, as opposed to structural you can often get a better, more attractive, finish by welding mild steel with a stainless steel filler rod.
15. Whenever possible always get yourself comfortable with support for your dominant hand/arm. You can often make a suitable armrest by clamping a piece of wood etc. to the work.
16. If you start making mistakes, or finding difficulties, check the condition of the Tungsten, it probably needs regrinding. If the Tungsten is ok then take a break for a few minutes.
17. Don't worry too much about all the gizmo settings; you will be able to make good and strong welds without them. Use of the gizmo's can be introduced as you gain more experience.
18. Robert recommends a three stage technique; first develop the weld pool, second add the filler wire, third move forward then start again at stage one.

**Notes on 'The Machine Shop Hinckley':**
Robert is a one man band with rather a unique business. His hobby is motorcycle sport and (shades of Phil Gregory?) he prepares his own bikes. He offers a welding and fabrication service, a basic welding course and runs his workshop as a DIY club. For a basic monthly membership fee of around £20 you can use his workshop and additional payments qualify you to use his equipment. I think a monthly fee of £50 allows you to use everything. The workshop is not lavishly equipped but includes all types of welding and cutting equipment, a centre lathe, pillar drill, guillotine, metal band saw and metal folder etc. Plus of course access to Robert's expertise. "IMO It would be helpful if every town had a 'Machine Shop' like Robert's!"

**Welding Problems I experienced:**
The main one was maintaining the electrode at the correct distance from the workpiece. Mistakes (including dipping the Tungsten in the pool or breaking the arc), normally happened when I was concentrating on adjusting the length of filler wire extending from my left hand. There is a technique for doing this but it requires an amount of finger dexterity and although I'm not bad with a pair of chopsticks in my right hand I've never really mastered feeding the wire through the fingers of my left hand. When oxy/acetylene welding I often cheat and dab the electrode in the weld pool then move the torch slightly away so the filler wire sticks in the edge of the pool, at which time I slide my hand up the filler wire; then bring the torch back in to reheat the pool and release the wire. Not strictly correct but I've got quite good at it over the years. You can buy a little gadget to make this aspect of welding easier (called a TIG wire feeder pen). Initially I decided to try and do without one but then succumbed and bought one; mainly for the simple reason it makes it easier to pick the filler wire up when wearing thick gloves, and you can use more of it without overheating the old pinkies.

**Note.**
*TIG welding is actually quite docile and unlike normal electric arc you are not bombarded with sparks and molten slag. I noticed that when Robert gave me a quick demo he didn't wear gloves, but suggested that not wearing gloves for longer periods of welding would result in sunburned hands. I noticed when I got home that my left hand and both wrists were red, even though I had only tried welding without gloves for a few minutes.*

**Tip: -** *Filler wire is available in various lengths, mostly from around 330mm to 1m. Unless you are a bit of a Scrooge and hold the last bit in a pair of long nose pliers you are going to have a fair bit of waste. Buying the 1m lengths and using a TIG wire feeder pen reduces the waste. (I don't have waste when gas welding as I tend to weld each off-cut onto the next piece of filler wire).*

**The 80:20 Rule:**
During my apprenticeship I spent the first year on bench fitting** and the use of different machines including a week on electric arc welding followed by a week on oxy/acetylene welding. Early on in our apprenticeship we were introduced to the '80:20 Rule' (a version of the 'Pareto Principle' in which Pareto demonstrated that approximately 20% of the people in Italy owned 80% of the land). It would be fair to say that the principle was reinforced on both those welding courses. As the TIG course progressed I realised that it was following a similar 80:20 pattern and within an hour or two the beads looked quite presentable.

**Notes.**
*** Unless you have made a pair of 4" x 2" x 1.5" 'V' blocks from a 5" cube of metal using only a hacksaw and files you have not experienced real pain! The ever helpful (sadistic), instructors took great delight in marking all six sides of the cube with a centre punch so that not one flat side/edge was usable.*

*I haven't heard much about the 80:20 Rule these past few decades but it was very common in the sixties and seventies. As applied to craft skills it used to indicate that you became 80% proficient in 20% of the course time (i.e. at the end of the first day on a five day course you were 80% proficient); it took the remaining four days to get that extra 20%. This assumes of course a 100% proficiency over the allotted course time.*

Back home post course my plan was to have more practise by making a welding trolley, in fact Before the course I had already found enough material in the bottom garage to make one. In the event I felt it would be much more useful to make the trolley using my spare chassis material (1" x 2" x 1/8" thick box section). With a rough plan in my head I measured the gas cylinder and welder then cut and degreased etc. the material. I did have some 10" diameter pneumatic wheels but decided that these were too large), so I quickly ordered a couple of rigid 5" diameter nylon castors off eBay and started cutting the metal to size. The finished trolley is shown below.

**Note.**
*Surprisingly there is as much welding in this trolley as there is in my basic ladder chassis prior to fitting the outriggers.*

**Welding Table:**
By the time I had finished making the welding trolley I was feeling more confident but as I had some minor pre-fabrication work to do on Pegasus's chassis, notably the manufacture of the spring hanger outriggers and welding the through tubes in the chassis cross members I decided to make a welding table. In my junk store (bottom garage), was a piece of steel plate 12" x 36" x 1/2" thick (I've had it over thirty years and always thought I'd find a use for it eventually). This was put in the wheelbarrow and moved to my carport (under which I was doing the welding), along with the previously rejected trolley metal. After making the table, including the fitting of some heavy duty castors I welded the through tubes into the chassis crossmembers and pre-fabricated the spring hanger outriggers. After this stage I started welding my main ladder chassis.

**Beginners Settings:**
Now it would have been helpful if the instruction book contained some initial machine settings for various metal thicknesses and joints, unfortunately these were conspicuous by their absence. Following a combination of Robert's Tips, correspondence with a very helpful gentleman called 'Ed' at R Tech, and my own post course experience I developed the following settings as an initial starting point.

**TIG Welding 1/8" Box Section:**
The following machine settings were determined.

1. Up Slope. = 0
2. Down Slope. = 0
3. Peak Amps. = 90 (approx 30amps per 1mm of mild steel thickness).
4. Pulse Frequency. = Not used yet.
5. Pulse Width. = Not used yet.
6. Pulse On. = Not used yet.
7. Pulse Off. = Set to off.
8. Select 2T or 4T. = 2T
9. Post Flow Gas. = 5
10. Base Amps. = 55 (approx 2/3rds of peak).
11. Warning LED. = Amber which goes out when checks complete.
12. Power LED. = Stays on green if checks are ok.
13. LED Display. As required for adjustment then shows the main amperage set.
14. TIG Starting Control. = HF.
15. Pre Flow Gas. = 0.5
16. Start Amps. = 5
17. End Amps. = 5
18. Memory Store. As required.
19. Select function. As required.
20. MMA (Stick), Settings. = N/A.
21. Selector Knob (press in for three seconds to save settings).

**As a general rule of thumb you'll want to go by the following:-**

- Stainless Steel – 25 amps per mm of thickness.
- Mild Steel – 30 amps per mm of thickness.
- Copper/Bronze Brazing – 40 amps per mm of thickness.
- If you start around there and tweak to your liking, you should be in the right ballpark.

**Tungsten Electrode Tip Protrusion:**

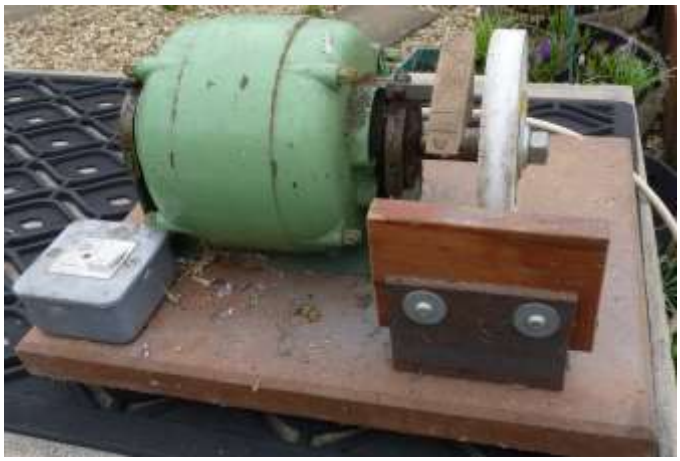
Following Robert's advice I tend to mostly use the #7 ceramic shrouds, often referred to as a 'cup'. It is recommended that the maximum Tungsten protrusion should not be greater than the inside diameter of the cup. For most welding jobs I have found that a protrusion of 5mm to 6mm is about right. When doing a 'Tee' or fillet weld you can extend the Tungsten slightly as the corner angle between the materials, keeps the gas more confined.

**Sharpening a Tungsten Electrode:**

If you touch the end of the electrode into the weld pool you will bugger the tip as a blob of molten metal forms on the end; any welding from this point on will be inferior, therefore you need to regrind the electrode. Don't be tempted to just grind the blob of metal away as it will have affected the Tungsten! Put the blob in a pair of pliers, bend the Tungsten (which is fairly brittle), and it will snap adjacent to the end of the pliers.

I mentioned earlier that the Tungsten electrode is **NOT** sacrificial, but it will be if you dip it in the pool too often when you first start welding. The Tungsten that came with my machine was 150mm long, by the time I had finished welding my trolley it was around 50mm long. Aftermarket Tungsten electrodes are normally 175mm long.

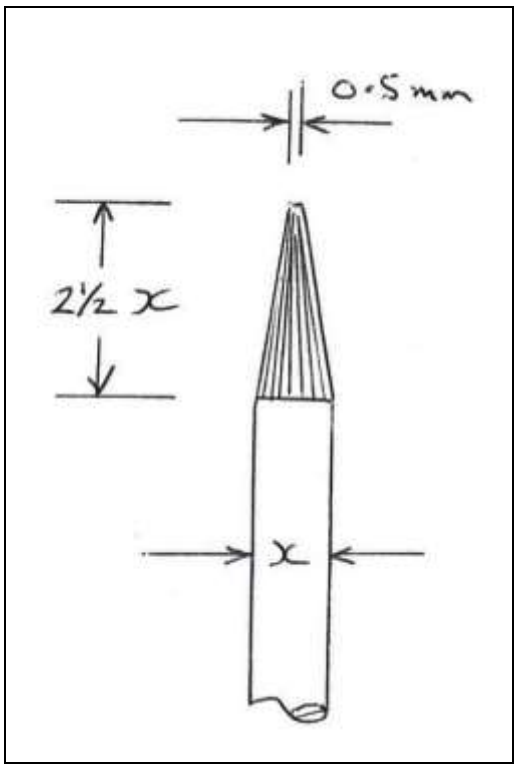
It is recommended that Tungsten grinding is best done with a diamond impregnated wheel but I found a 'White' wheel for high speed steel worked well. The Tungsten doesn't like contamination and should be ground on a dedicated 'Tungsten Only wheel' that is kept away from normal grinding dust etc. In my bottom garage I had a small 'White' wheel mounted on an electric motor that I used to use years ago for sharpening HSS woodworking tools, after a quick clean and dressing the wheel it was pressed into service.



**They don’t make them like that any more.**

**Note.**
*As re-discovered after nearly 20 years hidden away in the bottom garage. It was originally fitted to a 1959 Parnell washing machine which my mother-in-law gave to my wife in 1966. Three years later we bought a new washing machine and the motor was used to power a home made wood lathe. 15 years later it powered a Myford ML10 metal lathe and became the above grindstone some 4 years after that. It might look a bit dangerous but it rotates at such a slow speed that the tool tip keeps cool and I have time to duck if the wheel comes off.*

The main thing to remember is that for best results any grinding marks should be lengthwise. The following sketch shows the Tungsten tip shape for most jobs.




**Sharpening a Tungsten electrode.**

**Note.**
*The thinner the material the finer the point. I found that a 0.5mm wide point was suitable for my 1/8" thick material.*

**My Beginners Top Twenty Tips:**
1. Don't weld when tired.
2. Wear your safety kit.
3. Take care to avoid tripping over trailing leads.
4. If you haven't got a trolley secure your gas bottle against falling.
5. Buy a gas bottle outright, it's a lot cheaper than renting one.
6. Make an effort to get the machine settings correct but don't be afraid to change them if things go wrong.
7. Don't weld out of doors if it's windy as the shielding gas will blow away.
8. If you cannot strike an arc connect the earth cable.
9. If welding two different thicknesses start the weld pool on the thicker piece of material.
10. If things start to go wrong check the condition of your Tungsten electrode.
11. Buy some triangular shaped magnets; they are excellent for holding small metal parts square to each other while you tack them.
12. To make it easier to find keep your in-use filler wire on a magnet.
13. Ensure the work material is scrupulously clean.
14. Move and adjust the work if possible to get the best angle for welding.
15. Try and get a comfortable relaxed position with hand and arm support.
16. Try and position yourself and the work so you don't have strong sunlight behind you as it can cause reflections in the welding mask glass.
17. If you only wear glasses for reading try welding without them, I found this made a huge improvement as my glasses tended to mist up on cool days.
18. At the beginning you need a lot of concentration, limit your welding time to start with. As you improve and need less concentration you can weld for longer periods.
19. I found that the minimum usable length of Tungsten electrode was approximately 40mm. To grind a small length like this safely you need to hold it in a pin chuck etc.
20. Keep a small dedicated toolkit; e.g. a pair of pliers for snapping the end off fouled Tungsten electrodes, a couple of 90 degree magnets, a TIG wire feeder pen and a pin chuck for holding small lengths of Tungsten when grinding.

**Summary:**
Over the years I have often considered the purchase of a TIG welder but always thought it would just be something else that would get little use and be stored away most of the time. Considering all the hype I found it surprisingly easy to use.** My one pence course and the making of the welding trolley and table gave me enough skill, and confidence, to progress onto the making of the chassis. When I come to restore the suspension swinging arms I will grind off all the ugly welds then TIG weld them and weld on some mudguard mounting brackets.

**Note.**
*** Unfortunately when into my third practise session at home I just couldn't do anything right and made a total hash of things, managing to burn a hole in my workpiece. I don't know what went wrong and it brought me down to earth with a Big Bang. After unsuccessfully trying to get back on track I gave up for the day. That was a big blow to my confidence.*

As I have gained experience with TIG it has become my favourite welding method, it will never totally replace my oxy/acetylene kit but it is a very neat form of welding. If I want to weld some thick stuff I can change the cable (provided), and use a normal sacrificial powder coated electrode.

I've told all my close neighbours and friends (both of them), that I'm open for business on repayment. I wish I'd bought a TIG welder years ago.

If you fancy a TIG welder then my advice would be to go for it, it's not that difficult to use; or alternatively book yourself on a short course and see if you have got the aptitude before getting your wallet out. If you fancy doing aluminium welding then you need an AC/DC machine at around twice the price.

**Costings:**
Unfortunately buying a nice TIG welder for around £500 is only half the battle; by the time you have bought everything you need you will spend nearly double that. My purchases are listed below.

- R Tech TIG 160PD = £534
- 13 amp plug = £1.51
- 20 litre Argon gas bottle = £110
- 20 litres of pure Argon gas = £116
- Flow meter = £14.95 (includes £5 postage).
- Welding mask = £12.88 (According to Robert the viewing glass is the same but expensive masks are more comfortable as they have a better head band).
- Welders hat = £5.49
- Welding gloves = £8.49
- 1.6mm mild steel wire starter pack 100 x 1m lengths = £13.99
- 1.6mm stainless steel wire starter pack 100 x 1m lengths = £19.99 (Robert recommended 1mm diameter but 1.4m was much better value).
- 4-hour basic TIG course = £0.01
- Magnetic torch/gun stand = £15.50
- TIG wire feeder pen = £8.69
- 10 pack of 2.4mm purple tungsten electrodes 175mm length = £18.99
- 16 piece TIG torch accessories kit = £11.99
- Pack of ten #7 ceramic gas shields = £10.99
- Course fee waived by Robert (-£0.01).

**Total £903.4**6