

# Building **PYRTE**

## *The Firebox*

Now that you have the bulk of your boiler completed, what's needed next is a way to fasten it to the framework or body of your traction engine, and also a method of holding a fire directly beneath your boiler to concentrate its heat around the back end, and this calls for a firebox.

It is basically a box around the back half of your boiler, open (for now) at the top and vented at the lower rear end to allow air in to mix with the gas, that way making the flame burn properly.

*The original firebox took me around ten or twelve hours to complete owing to the fact I made my firebox and tender sides out of one piece (having no set plan to work to and thinking at the time that it would give more rigidity, but the extra awkwardness proved to be pointless, as the easiest way is to make the firebox and add the tender later, as will be shown here).*

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This chapter involves the construction of the fire-box and its materials and is rather fiddly, tedious even, but very simple to make, requiring lots of bolting and un-bolting of the parts as the build progresses.

If you imagine a steel sided box of 6 inches square and 8 inches tall, open at the top and bottom, with the two sides raised up to allow a shaft (the crankshaft) to rotate above the top level along with a raised rear, you will have a rough idea of what is needed at this point (the top and bottom of the box will be added later on), and although the width is 6 inches, the length is a nadders over, being 6.2 inches, but that is not so obvious.

Each upright corner joint along the straight edges needs a  $\frac{3}{8}$  square brass rod bolting in place, that way keeping the plates rigid and also held square to each other. The bottom sides need two and the top sides also need two. There are two others across the top front and rear, along with two at the bottom.

### **Tools needed:**

Very basic really...

- A hacksaw, a 3.6mm drill for your bolt holes, a larger drill ( $\frac{3}{8}$  or bigger - depends on your drill capacity - is ok) for the main boiler holes, files, a square, hammer, punch and scriber.
- Your electric screwdriver or hand drill with the 4ba and 5ba nut spinner previously used on the boiler (*for the loads of bolting and unbolting required*).
- Silver soldering gear for the rear boiler support ring.

### **Materials needed:**

- 1 piece of 0.1 inches (2½ mm) steel (or brass), 6 x 8½ inches (152 x 206mm) (for the *front*).

- 2 pieces of 0.1 inches (2 ½ mm) steel (or brass), 6 x 12 inches (152 x 304mm) (the sides).
- 1 piece of 0.1 inches (2½ mm) steel (or brass), 6 x 9½ inches (152 x 241mm) for the rear plate.
- 4 x 8⅝ inches x ⅜ square brass rod (the corner uprights) + 4 x 6 inches x ⅜ square brass rod (the sides – top and bottom).
- 4 x 4½ inch lengths of ⅜ square brass rod (*the top and bottom plate anchors – front and back*).
- 92 – 4ba steel or brass bolts with nuts, ¾ inch long (*for main firebox*).
- 24 – 4ba steel or brass bolts with nuts, ¾ inch long (*for boiler attachment*).
- 2 x 1 foot (300mm) lengths of ¼ inch (6mm) square brass rod (*boiler support rings*).
- Silver solder and flux.

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*If you are intending using brass bolts on these parts, the main problem here is the fact they are not too strong and can be easily stripped, so I recommend using steel bolts here and in the tender construction.*

*Another option is to use steel square rods for the corner bracing, although there needs to be some holes tapped 4ba to secure the top and bottom fire-box plates, and as 4ba taps are small and can break easily, that is the reason for using brass.*

The firebox is very simple in that it is made of oblong sheets of metal, cut to shape and held together with square section rods by nuts and bolts, and all the bolts are ¾ x 4BA, just to make your life easy. An alternative to this bolt size, should they be hard to find in your locality, is bolts with a ⅝ inch or a 3mm diameter thread (with the holes bored and tapping done to suit these sizes).

*Most of these bolts can be replaced by rivets if the urge takes you, but as this model is meant to be an easy build, all fastenings are nuts and bolts. This also aids with dismantling and re-assembly as the need arises.*

All the structural sheets of metal are 2.5mm thick (around 0.1”) and can be brass for ease of construction, although more expensive and very easily marked, or steel for robustness and economy, but you may need to protect it from rust if you are building this model in the middle of our winter.

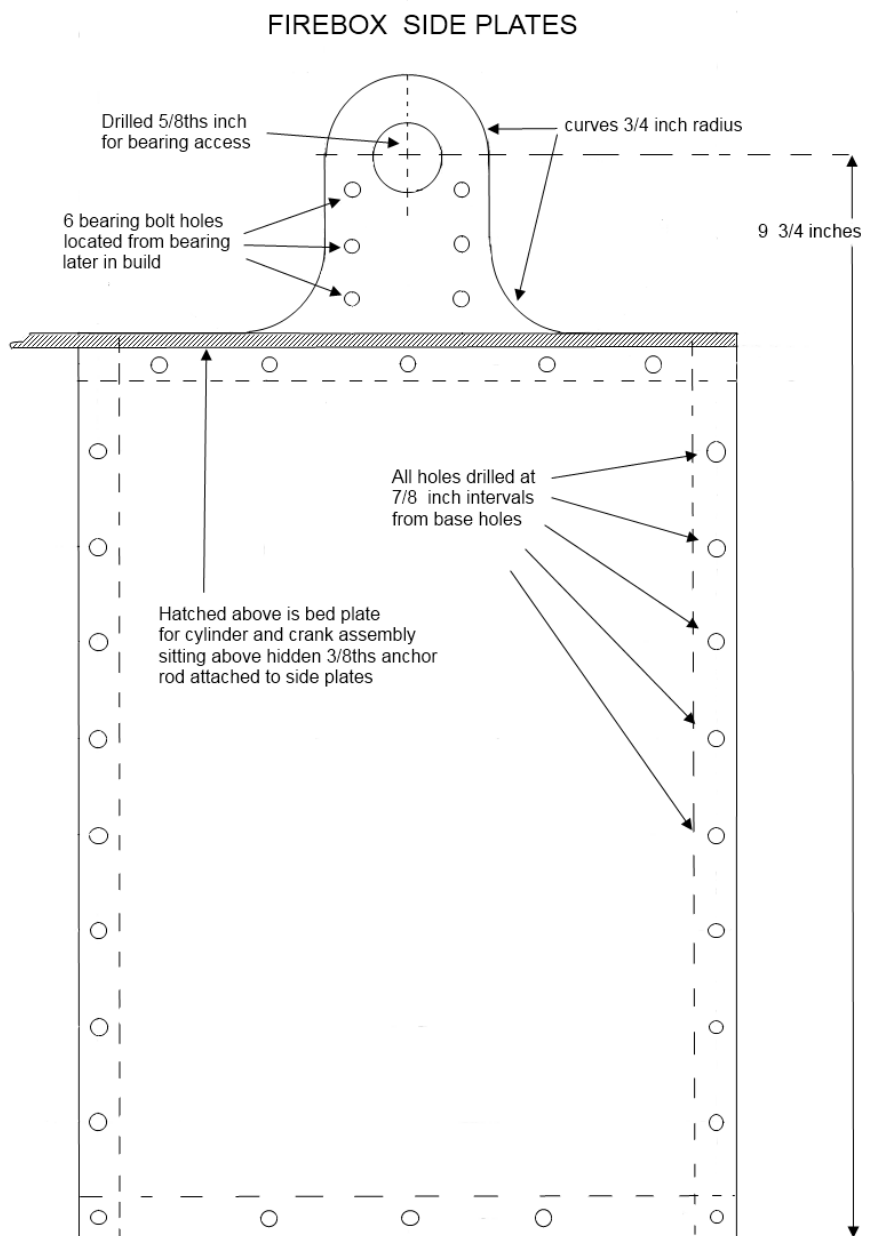
That’s the reason for the red paint sprayed on in some of the pictures.

You takes your pick, but steel is by far the better option regarding rigidity, which is something to be desired in these parts!

I did mine in steel rather than brass, so I will refer to steel in the build progress.

There is also a thinner sheet required (preferably steel) to be inserted around the boiler barrel and also at the front and rear of the firebox internally, that way keeping the heat concentrated where it is wanted, rather than heating all the metalwork to excess. This also helps to raise the steam temperature and therefore the pressure more easily with this simple boiler style.

But for now we are dealing with the outside shell of the firebox and will be covering the insulation aspect in a later chapter.



Firstly you need one piece of steel sheet, 6 x 8½ inches for the front plate, with two more at 6 x 12 inches for the sides and one at 6 inches by 9½ inches for the back plate.

*The two side plates have surplus metal to be removed from the top edges, but with small bolts through the surplus metal on the paired side plates, you can hold a side piece and its mirrored part together. You will save having to mark out other pieces and possible errors in dimensions between them, that way matching them up evenly.*

*This method should also be used on the paired tender sides described a little later on. The surplus can be*

*removed once the parts are drilled out and should be saved as they are needed a little later in the build.*

*Any marking out needs be done to one side only, so if you decide which face of each fire-box side is the outside face you wish to use, and placing the inside faces together, then with the front and*

*bottom edges straight and in line, a 3.6mm hole can be drilled through in a couple of places on the waste parts at the top, that way the two plates will be anchored together.*

## ***SIDE PLATES***

Take one of the side plates and with the front side straight and the bottom square to the front edge, then lightly scribe a line on the outside face parallel to the bottom edge at  $8\frac{1}{8}$  inches (206mm) and this gives the height of the underside of the fire-box top platform that the cylinder block sits on.

Two other lines need marking out from the bottom edge, being the centre lines for the bolt holes, so the first goes in at  $7\frac{15}{16}$  inches (201mm) for the upper bolts, and the second is at  $\frac{3}{16}$  inch (5mm) from the bottom.

Two other lines need scribing for the upright front and rear bolt centres, being at  $\frac{3}{16}$  inch (5mm) and  $5\frac{13}{16}$  inches (147mm) from the front edge. *(In the drawing these holes are shown not to scale for clarity.)*

The side/upright holes are at  $\frac{7}{8}$  inch (22mm) intervals on the side plates, making 9 holes in all each side, while the top five holes on the line marked at  $7\frac{15}{16}$  (201mm) from the bottom are marked with one hole sat centrally, two set in by  $1\frac{3}{4}$  inches (44mm) and the other two by  $\frac{3}{4}$  inch (19mm) from each side, these need to be marked and carefully centre-punched ready for drilling.

The three lower bolt holes on the side plates match the three inner positions of the upper holes.

Next you need to mark the inside faces of the two plates (I suggest a felt-tipped pen) so that the side of each plate can be distinguished once they are separated. This covers any irregularities in the sheets owing to slight variations with the centre-punching or drilling, that way you can always know which sheet is which, and which way it goes round for the build.

Two bolts now need to be tightly placed in the surplus regions, allowing the two sheets to be held firmly together while drilling operations are carried out, but make sure you have the two sheets/plates the right way round and the bottom and front edges are equal and level.

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*Using a bench drill on larger pieces of sheet metal can be a bit awkward, especially if the column of the drill gets in the way and as these will not fit flatly in a vice, safety can be a problem, and I have to admit that mine were drilled with a hand drill while sat in the vice, so they were secure anyway, although not exactly in a straight line, but that is not so obvious once everything is covered in paint. Another point to consider, especially if you follow my method, the vice may well leave impression marks on your work, so a couple of soft jaws (made from either aluminium or copper sheet, even hard wood at a push) with enough material to cover the complete vertical face of each jaw of your vice, along with the same overlapped and bent flat over the top so they sit on the top of the jaws for support purposes, works wonders in the soft metals department.*

All holes in the side plates are drilled with a 4BA clearance (3.6mm) drill and a  $\frac{7}{8}$  hole for the bearing needs removing. Once the drilling is done, remove all the burrs with a fine file, pop the drill through once again to make sure the holes are clear, and we shall then go onto the front and rear fire-box plates.

## ***FRONT AND REAR PLATES***

These plates too are almost identical, both needing a hole just large enough to allow the boiler barrel to enter it, with the bolts on the upright edges sitting midway between the bolts at the sides (see picture below), although the rear plate is taller and has a further hole removed for heating access.



*(The staggering of the fire-box bolts can be seen quite plainly in this early picture, but was taken when a different, more difficult mounting for the boiler to fire-box procedure was in place, so please ignore the ¼ inch gap at the boiler/fire-box joint.*

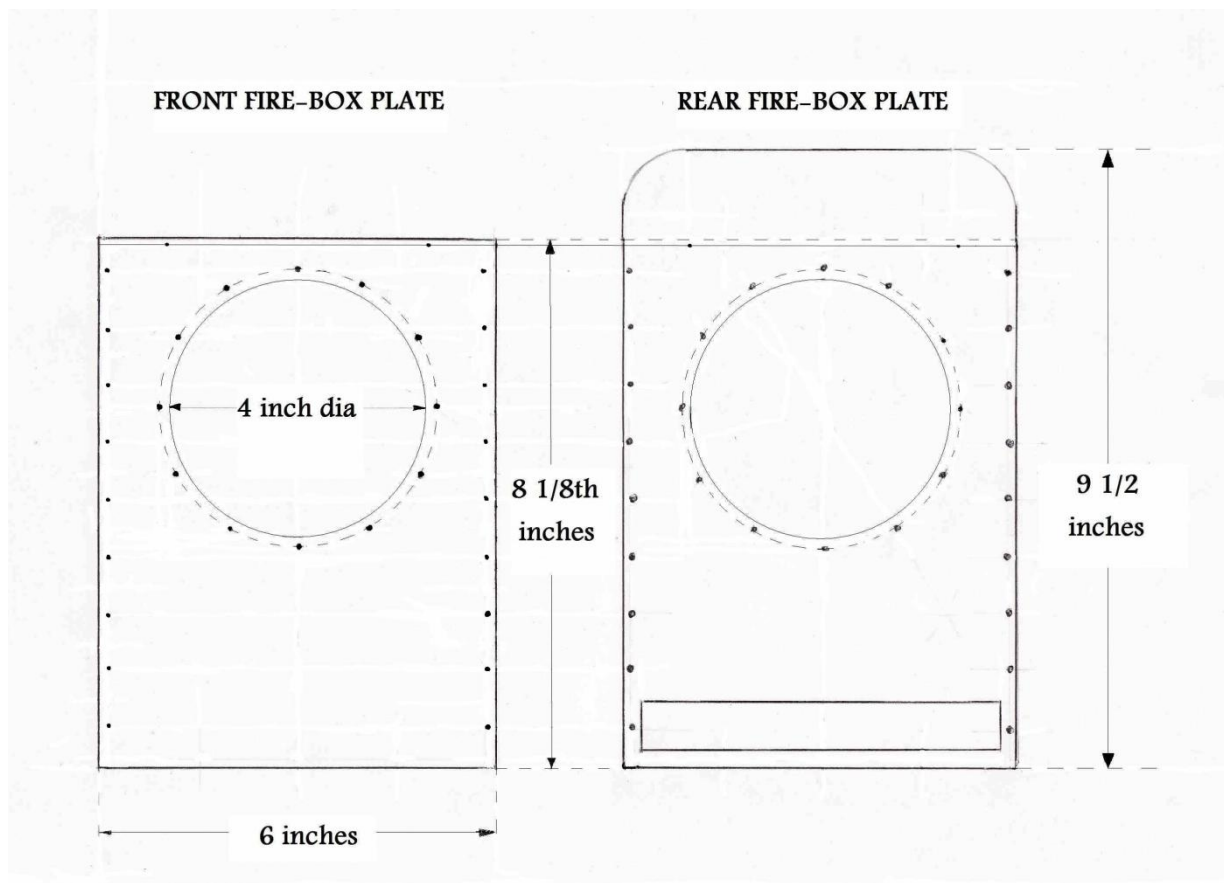
*Note also the ⅞ inch bolt spacing on the side plates, and this is also before any heating was included, that way there are no bolt holes at the bottom of the side plates and the front plate! The build was simply an ongoing process at this time.)*

There is, however, (*again, not shown correctly here*) a need to have the edge of the front and rear plates sitting level with the outside face of the side plates, and this will have to be done to suit your metal sheet thickness accordingly, as you are looking for an overall width of your fire-box of 6 inches.

## **THE FRONT PLATE**

Taking the piece you have selected for the front, having squared the piece at 6 inches wide, first mark off the top of the plate at  $8\frac{7}{8}$  inches (206mm). Next mark off the upright centre line (at 3 inches – 75mm) for its full height and along that centre line, up from the bottom measure  $5\frac{1}{2}$  inches. This is the centre height of your boiler. You now need to scribe a circle to match the outside diameter of your boiler (4 inches) from this point along with a second one at  $4\frac{1}{4}$  inches diameter for the centre of your boiler support ring bolt holes.

If you now scribe a line along each side edge at  $\frac{3}{16}$  (5mm) in, plus the thickness of the sheet metal you are using for the sides, this will give your centre line for your drilling ( $7\frac{1}{2}$  mm worked just fine here with the materials I was using). *This centre line is really the centre line for your upright square section rods sitting behind your side plates, which was not allowed for in the picture shown above.*



As the side panels have a bolt hole at  $\frac{3}{16}$  (5mm) of an inch up from the bottom edge, with a second hole at  $\frac{7}{8}$  of an inch above that and the next at  $\frac{7}{8}$  again, then midway for the first (lowest) hole on the front panel is  $\frac{5}{8}$  of an inch up from the bottom edge, with the next hole at  $\frac{7}{8}$  above that, then  $\frac{7}{8}$  again, *making them sit mid-way between the side bolts when assembled*, with each of these nine holes, both sides, needing marking accordingly.

Next we need to mark out the bolt holes for the boiler support rings (*the two pieces of  $\frac{1}{4}$  inch square brass – to be installed soon*) and this is achieved by using a compass and drawing a 4 inch circle on a plain sheet of paper and dividing the circumference into 12 equal sections with your compass, (*you could even do it on your front sheet, using a centre punch at the centre of the boiler centre line*) a simple child's school compass does the job, and by drawing from one point through the centre of your circle to the opposite point, you then can position that line on your plate in line with the scribed centre of your plate, with the centre point of your circle at the centre height of your boiler.

Mark each of the 12 points where they cross the  $4\frac{1}{4}$  inches diameter circle, and these will be your bolt hole centres.

The 3 upper and lower holes on your front plate (not really marked properly on the drawing above for both top and bottom horizontal anchor rods - allowing the fire-box top plate and the fire-box bottom plate to be added later on) now need marking, so scribe a line across the top of the front plate at  $7\frac{5}{16}$  inches above the bottom edge, with a mark from each side edge at  $1\frac{3}{4}$  inches and one

in the centre. Repeat the marking at the bottom making the centre height at  $\frac{3}{16}$  inch up from the bottom.

With all bolt hole points centre punched lightly, and this time, with two or three holes bored inside the 4 inch circle on your front plate with your 3.6mm drill, then line up the plates (both the front and back, with the bottoms and sides level), clamp them together once they are lined up correctly and drill the plates for the bolt holes within the 4 inch circle, using the front plate as a guide for your drill.

When bolted together through these holes, do not pull them apart until all your plate work drilling on these items is completed, and all the marked bolt holes are drilled out. As you go on, insert more bolts in the perimeter holes and nut them tightly before removing the few original ones in the central boiler barrel hole (to be), that way the plates remain together for the removal of the central hole.

The large centre holes for the boiler needs to be chain drilled, (*that simply means drilling holes very close together to form a line so that a hacksaw blade can be inserted in the drilled "slot" to make it easier to remove the bulk of the 4 inch circles*) or alternatively can be drilled a much larger size to gain entry for your hacksaw blade. A little tender usage of a file will be needed to remove the inside of the 4 inch circle, and you will need to check that the boiler barrel slips in the holes without any snagging. A very small amount of clearance is preferred, but do not overdo it as the bolts will need some sheet metal to anchor onto, and any irregularities in these plates will be obvious on your completed traction engine.

While they are bolted together, scribe a line right across the top of the back plate to show the height of the front plate, (*this is to show the top of the rear anchor rod – sitting level with the upper dashed line on the drawing above*).

With everything complete so far, the plates can be separated and the lower air/access hole in the rear one now needs marking out and removing.

This, basically, provides access for the burner and an ignition point, as well as air entry. So scribe a line across at  $\frac{3}{8}$  inch up from the bottom, with a further one at  $1\frac{1}{8}$  up. Two more need scribing for the sides, allowing  $\frac{3}{8}$  inch plus the thickness of your side sheet, making them  $0.375 + 0.1$  inches = 0.475 inches from the outside edge of your back plate. This oblong shape now needs removing, but be careful with the remaining plate metal as it is likely to become mis-shapen.

*A simple tip here is to delay removing the oblong section until you have the rear plate bolted to the sides of the fire-box, that way giving it more rigidity.*

The curves on the top corners of your rear plate are merely for decoration purposes and to take the sharp corners off, and mine were done at a one inch radius.

A further centre line needs marking out from the bottom of the boiler hole to the middle of the bottom edge and sitting on the proposed inside face on the rear plate.

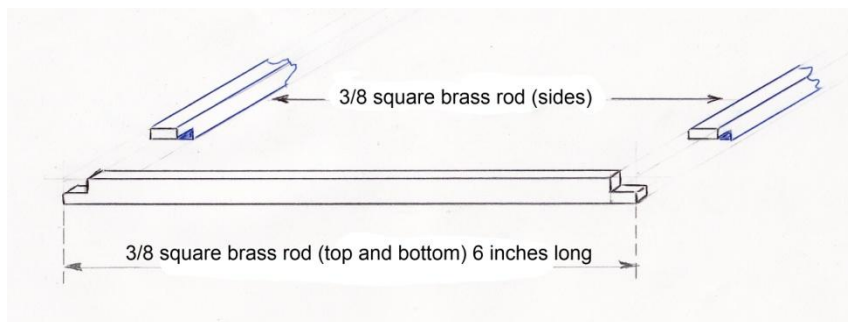
With the plates all de-burred and cleaned up, the next job is the corners as a way of fastening these plates together.

## ANCHOR RODS

Starting with the side plate on the left hand side only, cut four pieces of the  $\frac{3}{8}$  inch square section brass rod to the same length as the width of your plate (6 inches).

The rods now need trimming back for half their thickness for the length of their thickness ( $\frac{3}{8} \times \frac{3}{16}$ ) to allow the upright rods (referred to as the sides in the hand-drawn sketch below) to overlap their ends at 90° at both ends.

A rod each will be attached at the lower and upper edges of the first side you are dealing with,



where they butt up to the top and lower plates, with the other two doing the same for the right hand side plate, and it is wisest to deal with each plate individually and to mark each one to show its correct position on

assembly.

*I marked all mine with a letter punch, BLF and BLA to show the Bottom, Left, Front and Bottom, Left, Aft, (calling it BLR may cause some confusion as it could mean bottom, left right or rear) and marked them on the face that would go against the left hand side panel in this case, so that if ever I had to split the firebox again for any reason (in particular the painting), I could re-assemble it back together without too much trouble. And was I glad I did with all the mistakes I had made back then! This is now normal practice for me. In your case, if you have no punches, then use something to identify each part for yourself - they will be hidden from view, so a few small hacksaw or file marks does the trick nicely – even different coloured felt tips do the job, although these can get wiped off.*

With the rod lined up with the bottom of the left hand side panel, sitting as if on the inside of the plate and the ends flush with the upright edges, then, once clamped together, the holes can be drilled with a 3mm drill, using the centre-punched marks in the bottom of the plate as a guide.

This 3mm drill is tapping size for the 4ba bolts you will be using.

The top edge requires the same treatment, as does the right hand side plate (*not forgetting to mark the rods and sit them on the proposed inside of the fire-box*).

Now tap the brass rods for a 4ba thread before opening up the firebox holes to clearance size at 3.6mm.

If you now bolt up loosely all but the outer holes, fixing the rods to the sides at the top and bottom, you can then begin to install the upright rods on this left hand side section.



All upright  $\frac{3}{8}$  inch rods run from the top, level with the top of the upper  $\frac{3}{8}$  inch square rod you have just put in, down to the bottom of the lower  $\frac{3}{8}$  inch rod, being  $8\frac{1}{2}$  inches long, with the width of the ends cut back to match the two mating ends ( $\frac{3}{8} \times \frac{3}{16}$ ).

Starting at the front, place the front upright rod flush against the front edge of the left hand plate, sitting behind it and the overlapping corners in place, mark through one end of the front upright rod using the front (outer) bolt holes on the side plate as a guide.

This can now be drilled with a 3mm and tapped 4ba.

If you do one first, open up the hole through the plate at 3.6mm then bolt it up, this locks your front upright rod in position so you can then mark and drill the other end. *(As there is not much in the way of flexibility with using the 3.6mm drill as it is barely bigger than the overall diameter of a 4ba thread, rather than having to open up the holes to a larger size, it is better to lock parts into place before drilling commences.)*

With a bolt in the lower and upper end holes, locking the front rod in position behind the left side plate, complete drill the other eight holes at 3mm through the plate and rod using the side plate as a guide, and then the same on the rear upright left hand side rod, before completing the right hand plate in the same manner.

Finally open up the plate holes to 3.6mm and tap the rod holes at 4ba before bolting it all together.

You will now have two side plates with a  $\frac{3}{8}$  inch rod (lip) sitting completely around the inside edges.

*Obviously you will have realized by now it is far better to have 2 drills handy, one with the number 31 (3mm) installed and the other with a 3.6mm so you are not swapping back and too all the time.*

## Front Plate Anchor Rods

Moving on to the front plate, 2 x  $\frac{3}{8}$  inch square rods need to be installed first, one each at the bottom and top.

These rods are not the full width of the front as they have to sit between the side rods and also allow room for the bolt ends to protrude beyond these side rods at their overlap point. They are simply to add a bit of rigidity to the plates (and also the lower front acts as an anchor point for the conventional steering arrangement that you may want to add as an improvement), whilst the upper rods, both front and rear, act as anchor points for the top cylinder platform. The length of these four rods is  $4\frac{1}{2}$  inches maximum.

With a mid-point marked along their length, line up and clamp the top rod centrally with the top edge, flush with the top of your front face, and drill the three bolt holes using the front face as a guide. Repeat this for the bottom edge, and then again for the rear plate, using the line scribed above the front plate when they were together as your level for the top of the upper anchor rod.

In lining up the front plate to the side plates, the aim here is to make sure the holes are drilled through the plates into the centre of the upright rods, keeping everything even, not forgetting to

allow for the extra thickness of your side plates, so the edge of the front and rear plates sit flush with the outside of the side plates, and you should end up with a sturdy box section tube at exactly 6 inches wide, although the length from front to back is just a nagger's larger.

## **BRASS BOILER SUPPORT RINGS**

Take both of the square brass rods and soften them (heat and quench, just like the copper, it's known as to 'anneal' the metal (if you are unsure, check out <http://steamshed.com> for the annealing guide) and shape them round the complete piece of wood you used to support the boiler barrel in the lathe.

*The front boiler support ring is a little more awkward, as if it is soldered on first, there is no way to drill the holes using the front plate as a guide, so here the ring needs to be bolted to the front plate first, to sit around your boiler very closely, and to be 'cemented' in place, rather than soldered on. This is no problem, as when the boiler heats up, it does expand slightly in diameter and will grip against the ring. Plus the bulk of the weight of this engine, along with the forwards motive force, puts most stress on the rear axle and wheels, meaning the rear plate of the firebox takes virtually all the strain, and my years of running this model proves its durability.*

So, let us begin...

With your boiler (sat upright on its back end) place your bolted-together fire-box on your boiler with the back end sat down on the face of a flat surface (a thermal builders block is great) and flush with the back of your boiler.

Slip the brass ring on and let it sit on top of your firebox front plate – *I know, it should sit behind the front plate, but this is merely for marking purposes* - and with the gap in the ring towards the top centre-line on your boiler, you can check to see it is a relatively tight fit.

If it needs the diameter of the ring reducing or opening up slightly, you will realize and can take the appropriate action to remedy it before any holes are drilled in the ring.

When you are satisfied with the very snug fit, simply mark the ring in line with the bottom boiler support ring hole already drilled in your front plate.

Take off the ring and scribe a central line across this mark at half way between the inner and outer diameters of your ring for the drilling position and bore it through at 3.6mm.

If you now lift off your fire-box and bolt the ring loosely to the inside of your fire-box front plate. The fire-box can now be replaced on your boiler, sliding the ring down the boiler barrel and can now be checked for tightness and in this position, clamped against the rear of the front plate at the top and holding the ring close to the boiler barrel, literally just at one end of the ring.

Slip the firebox and ring off the boiler tube and simply bore a hole through as near to your clamp as possible, using the uppermost available boiler support ring hole in your front plate as a guide, then bolt together with a third hole done in the same manner for the other loose end of the ring, but do

make sure you keep the ring snugly against the outside of the boiler barrel, just to make sure it is still a good fit before you clamp and drill the third hole.

Once you have the three bolts in place, you can now drill the remaining nine supporting holes using the front plate as a guide and bolt it properly into place. *(The top one serves no purpose other than to make the bolts look uniform to the onlooker, so a shorter bolt can be used if you wish.)*

**The rear plate** now needs removing from your fire-box.

*The rear brass ring needs shaping round the original wooden boiler tube support you used in the lathe, but the dimension of 4 inches (100mm) from the wooden tube support will be a little less than the outside dimension of your barrel, but the brass ring should grip the boiler barrel tight enough for soldering purposes. If you find the brass ring springs back to a larger diameter, making it unsuitable for silver soldering owing to the lack of close contact, then it may require softening again, or it may be better to use the smaller diameter that was used for the anchor rings and to have a relatively tight fit that needs a little easing to get it onto the outside the barrel.*

If you now clean and shine the end  $\frac{3}{4}$  inch of the outside of the back end of your boiler barrel, along with the inside of the brass ring, plus a little way up from the inside on the edges, anoint the cleaned parts with flux and mount the boiler barrel upright on its back end with the ring sat levelly on three or four small pieces of the waste metal from the side plates and encircling your barrel - but not in contact with it, that way positioning the ring to allow the boiler barrel to just poke through the ring for the thickness of your back-plate and would then sit flush with the outside of the back plate.

The brass ring can be turned to a position where the gap straddles the top centre line of your boiler.

All that's needed now is to silver solder the ring onto your boiler, but do make sure the boiler is vented before applying any heat and concentrate your heat on the boiler itself and let the copper heat up the brass as brass has a melting point just a little higher than silver solder.

Any previously soldered parts will be fine as you are applying heat to the outside of your boiler, rather than on the end, which should be sat on a block or something similar, that way shielding the end from excess heat.

*Another point is that as you do not want the waste pieces of metal attached to your boiler, before you mount the ring on them, hold them over a candle for a few minutes, that way allowing the soot to cover them. This stops any silver solder from bonding to them, even if the flux manages to run onto them.*

Once you have soldered and cleaned it all up, you then need to drill the holes for your bolts and attach the rear plate to the boiler barrel and for this you should bolt together your firebox around the rear end of your boiler, using the front end ring already bolted to the front plate, that way allowing the rear plate to sit squarely. You need to line it all up with the bottom centre line of your boiler sitting centrally on the marked inner centre line of your rear plate with the larger part sticking out at the bottom (do make sure your boiler is not 180° out otherwise your fittings at the back of the

boiler will be totally wrong on your traction engine), and do make sure you have the inside of the back-plate facing towards the front of your boiler!

With it all lined up properly, simply drill through the brass ring, using the rear plate as a guide, and bolt the rear plate onto the boiler support ring.

Do not be tempted to over-tighten the bolts on your fire-box as the fire-box will need to be split several times in the building process.

What you should have now is your boiler barrel sitting in your firebox with the rear end sitting flush with the rear plate.

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The next part of the firebox project should be providing the insulation, although this will be added when the time comes to be adding the cylinder bed plate at the top of the firebox as the main firebox will need to be dismantled a few times in the build process.

The base of the firebox will be added at the time of the burner installation.