

So we now come to build the tender for **PYRTE**

This is a similar fiddly process as with the firebox, using the same tools, but this time you will need an additional length of 1 inch (25mm) diameter steel round bar to form the shape of the back of your tender, along with a stout hammer and a block of wood.

MATERIALS needed

- 2 pieces of 0.1 inches (2½ mm) steel (or brass), 8½ x 8⅝ inches (216 x 206mm) (for the 2 sides).
- 1 piece of 0.1 inches (2½ mm) steel (or brass), 6 x 15 inches (152 x 450mm) for the floor/rear plate.
- 2 x 15 inch lengths (450mm) of ¼ inch (6mm) square steel or brass rod (the corner bracing).
- 68 – 4ba bolts with nuts, ¾ inch (19mm) long.



It looks complicated, but is very easy to do.

The tender is the rear part of your traction engine where the main axle of your engine sits, along with the lay shaft supporting the transfer gears, your water tank, pump and other odds and ends a driver will need (some of which can be



seen in these early rear view pictures of the second traction engine I made, BERNIE, which does not show the recently added bush in the rear boiler plate for the mechanical pump over to the left hand side of the bottom sight gauge bush).

The bearings for the rear axle are attached to this, along with a robust towing hitch at the rear, allowing a trailer to be towed behind with its gas and further water supplies, and most importantly, yours truly to control everything.

The towing hitch is fastened to towing straps (often called tender straps), again fastened to the rear axle on the outside of the tender body, that way reinforcing the sides of the tender to provide strength for any turning forces applied to your trailer, rather than having the tender twisting all over the show, and at the same time allowing the rear axle to take most of the towing strain directly.

First of all, you can ignore the towing hitch in the middle of the drawing below for now, as we need to concentrate on the side panels first. It is there to give you a guide of its position.

To start off with making the side panels you need two pieces of the same thickness of steel that was used for the smoke-box. Both pieces are identical and are 8 ½ by 8 ⅝ inches (216 x 206mm).

From the base a line needs marking at $6\frac{5}{8}$ inches (135mm) to show the rear of the tender height. Another needs marking for the main axle at 3 inches (75mm) upwards (*do mark this along the full width of the plate, along with a line at $\frac{3}{8}$ (10mm) either side of this line from the axle point to the rear – this is just beyond the outside edges of your towing strap for later positioning*) and you need a further one for the lay-shaft at 6 inches (150mm). Two more are needed, one for the lower line of the rear of the tender at $1\frac{1}{2}$ inches (37mm), with a final one at $1\frac{5}{8}$ inches (40mm) for the bolt holes.

This is an easy way round this extra plate width on the tender by marking the line at $\frac{1}{8}$ th (3mm) and rounding off the corners once the tender is complete, although it gives the appearance that the bolts are a little off-set, but is not really anything to worry about, as the rounded corners give the impression the build was done in the conventional manner, and this is the way we shall proceed with the tender here.

All arcs as can be seen on the drawing are at $\frac{3}{4}$ inch (19mm) radius.

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At the crossing point for the rear axle, mark a circle at 1 inch (25mm) diameter, with a $\frac{1}{2}$ inch (12mm) diameter at the lay-shaft centre point (this lay-shaft hole will need extending a little to allow for adjustment of the chains, but it is the centre we are dealing with at the moment).

With the two side panels lined up, bottoms and front edges together, drill through the surplus with a 3.6mm drill in four places and bolt them together, 2 at the bottom and 2 at the top in the 'to be removed' surplus.

Centre punch the rear axle and lay-shaft centre points and drill out with the 3.6 mm drill and bolt through these points.

Next, remove the back end, *the place where the towing hitch sits*, and once this is done, a mark can be made along the rear axle height from the freshly trimmed rear edge, to provide a bolt hole at $\frac{1}{8}$ inch (3mm) in.

Insert another 4ba bolt in this position, that way there are seven bolts holding the plates together before removing the surplus from around the edges of the plates, reducing it down to three bolts holding the plates together.

Once you are happy with the shape of the edges, a line can be scribed at $\frac{1}{8}$ inch (3mm) in for the bolt holes around the back end, from the top of the tender at the rear, to marry in to the $1\frac{5}{8}$ inch (40mm) mark that was marked in from the bottom originally.

Next we need to mark and drill the bottom hole up by $\frac{1}{8}$ inch (3mm) and $\frac{1}{8}$ inch (3mm) of an inch in (already marked on the left hand side of the drawing). This is the bottom left hand hole on the drawing, where it is attached to the bottom rear of the fire-box side plate.

With bolts in these holes securing the two tender sides together, remove the bolts in the shaft centres and drill or file very closely the two larger holes for the shafts.

The remainder of the bolt holes around the back and bottom of the tender will have to be guesstimated, but all I did was to mark mine at $\frac{3}{4}$ inch (19mm) intervals from the one at the rear (the

rear axle centre height and ⅛ inch (3mm) from the rear, but omit the ones along the drawbar for now) and very little adjustment was needed to make them look evenly spaced.

Unbolt the two plates, making a point of marking each, preferably around 2½ inches (63mm) below the main axle bearing centre point and on the inside of the plates to show which side is which.

The fire-box now needs to be pulled apart so that you can line up the front of the left hand side plate of the tender with the rear of the left hand side plate of the fire-box. The easiest way to do this is to use the rear left hand side upright anchor rod from the firebox as a guide, sat on the outside face of the left hand side plate for the tender, and with the front edge of the tender plate sitting flush with the front edge of the rod. (Your already marked rod should have the marks you provided showing so that you have it the right way round.)

With a bolt in the bottom hole and the two parts clamped together and the front edge in line, drill the top one first and bolt it up before the remaining holes can be bored through the plate using the rod as a guide.

You may need to run the drill through once again before final assembly as there may well be slight deviations owing to the squareness of the drilling in the rod.

With the holes drilled, and the opposite side done in a similar manner, the next part is to shape and attach the ¼ inch (6mm) supporting rod to the base and rear insides of your tender to allow the floor and back to be attached in one piece.

Reverting back to the left hand side, the ¼ inch (6mm) steel rod can be bent cold (without any heat treatment to soften it), provided you do not over-work the metal. What you need is a length of 15 inches (375mm) each - just a little longer than is shown by the ¼ inch (6mm) hidden (*dashed*) line on the drawing.

The rod needs to be kept away from the fire-box back-plate by a ¼ inch (6mm) at the front and runs straight from the front to where it rises up the back to the top of the tender and you need to bend the rod around the 1 inch (25mm) diameter bar to get the corners looking right. *It does not follow the line of the lower curves at the bottom of the tender sides.*

What I did was to hold the two pieces of rod against the horizontal round bar in my vice, making a point of doing the two together to achieve the same shape, and checking they were sitting square to the round bar, with the bar top slightly higher than the level of the top of my vice and pushed the upper ends down towards the back to form the right angle bends for the rear of the tender floor.

The measurement from the ends of the rods to the contact point on the bar is 8 inches (200mm) and will require just a little taking off when it comes to final assembly.

With the upper ends of the ¼ inch (6mm) rods shaped to match the rear of the tender, going from the base flat to the upright rear, they need to be equally bent, and the sides of the bends flattened out a little (the compression and stretching effect distorting the square metal again), you now need to fasten these rods to your tender sides.

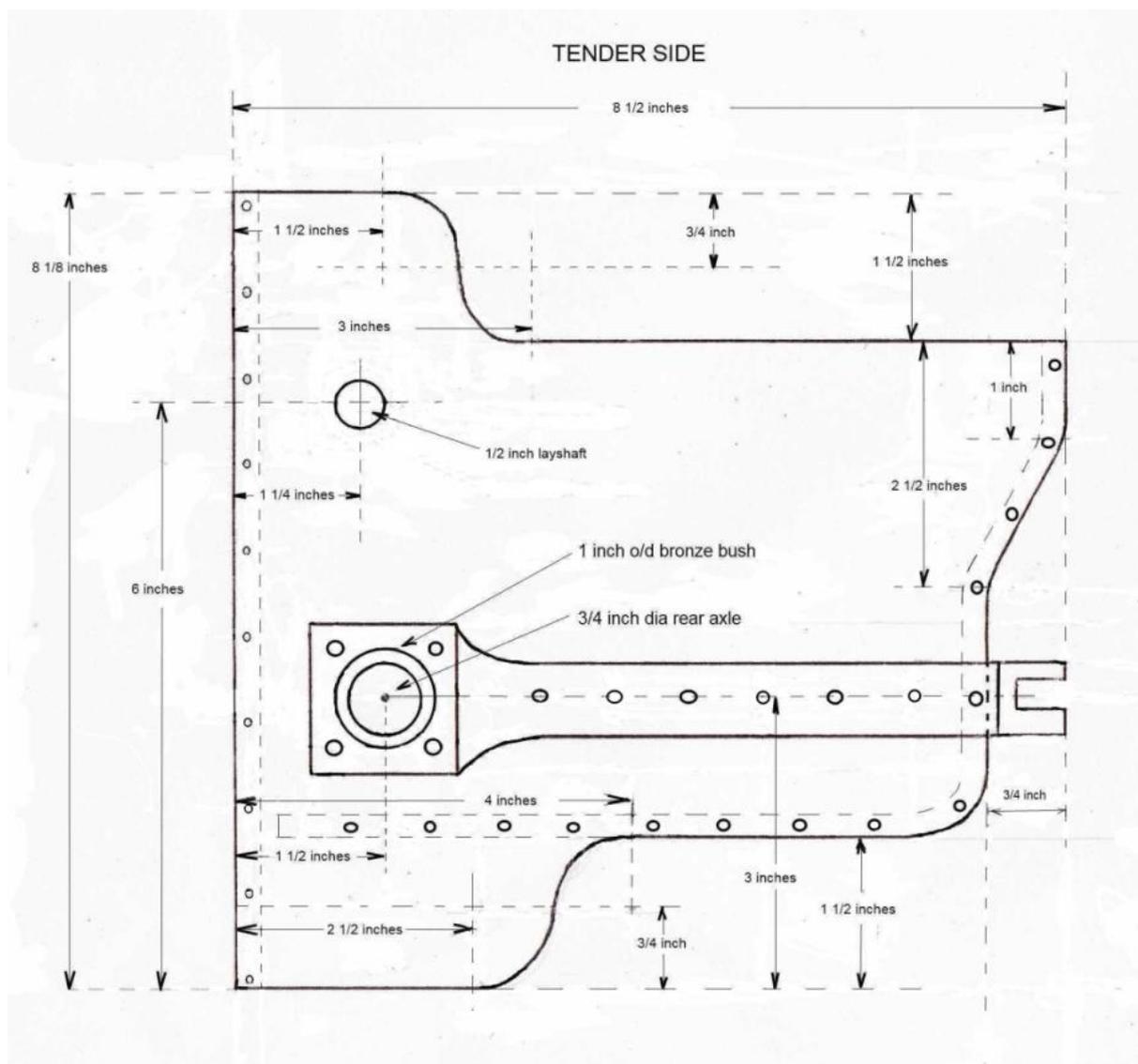
Clamp one of the shaped rods to the rear of the left hand side plate of the tender, matching the shapes at the rear end, and drill through the rod where the hole sits at the rear for your central point

of your drawbar/rear axle height, bolt it up and then run your drill through at the $\frac{3}{4}$ inch (19mm + or -) marks from your side plate, leaving the one at the top for now along with the two nearest the front.

It is wisest to drill one at a time and then bolt it up before moving on to the next hole position, that way you can get the bar to be a very close fit to the edge of your side plate. Do not be tempted to mark or drill the holes along the drawbar position at this point – that will be done when the drawbar is completed.

Repeat the process for the other tender side.

The floor and rear end plate comes next.



Mark the two long sides of the floor/rear plate at $\frac{1}{8}$ inch (3mm) in for the full length to show where the centre of the bolt holes sit. The length of this plate starts off at 15 inches (375mm) by 6 inches (150mm) and as it matches the same width as the fire-box, it sits perfectly inside the tender plates at the front (*that was the reason for the off-set, and keeps the rear axle square to the boiler, that way*

keeping bearing friction to a minimum), and it starts almost butted up to the rear of the fire-box, runs straight along and underneath the $\frac{1}{4}$ inch (6mm) rods and follows the shape of the rods and inside edges of the tender sides, sitting flush with the rods outer edge.

This is a little awkward to do - the bending in exactly the right place - so what you need to do is to measure down from the proposed top end for a distance of 3 inches (75mm), and here you need to make a slight bend in the plate. This point is the backwards (right hand on the drawing) bend, sitting just above the towing hitch on the rear of your engine shown at $2\frac{1}{2}$ inches down from the rear of your tender top.

This sheet is also the part that needs a little TLC regarding the use of the wooden block and hammer to persuade it round the bar to follow the shape needed.

If you decide to do it the other way round (bottom or extreme top first), getting this bend in place is very awkward to do.

If you now place your tender side (with the rear of the tender with the bend you have just formed in position, take a mark from the bolt, level with the back axle centre, round to the rear plate.

What is needed now is to drill two holes through the plate to secure it to the tender side so you can get the bottom bend in position, but firstly the towing hitch and towing strap, where they go around the back of the tender, need to be allowed for.

The depth of the towing strap and towing hitch is $\frac{3}{4}$ inch (19mm), so you need to allow $\frac{9}{16}$ inch (14mm) either side of this mark as your bolt-hole centres (the extra is *to allow the bolt heads to sit flush with the tender floor/rear plate*), sitting directly on the $\frac{1}{8}$ inch (3mm) lines down the side you have already marked. *The strap/towing hitch support, sitting at the rear of the tender, holds the plate against the anchor rods, so we start on either side of that position.*

With the first holes marked at $\frac{9}{16}$ inch (14mm) above and below this point, simply bore through with your 3.6mm drill on the crossing points. You may need to use a few 1 inch (25mm) 4ba bolts to get you started owing to the bends in the metal, and they need to be pinched up tight, with the same on the right hand side plate – these will be replaced once the rear plate is close fitting.

Make sure the two tender sides are parallel and square looking, and bend the sheet to match the shape of the rear and floor of the tender before marking the remaining positions for the bolts on either side of these latest bolts. What you need to do, as these points are to be on uneven surfaces, is judge them by eye to fit evenly between the bolt heads on the side plates. The $\frac{3}{4}$ inch (19mm) measurement does not quite ring true here, and simply bore the holes and bolt the parts together.

Trim the surplus from the front and the top, making a point of keeping the top edge level with the two sides. The front edge needs to have the surplus removed so that when assembled to the firebox, there is a $\frac{1}{4}$ inch (6mm) gap between the rear fire-box plate and the front of the floor/back plate of the tender.

This is to allow pipes to go through the gap, as well as drainage, should the need arise.

Here, the surplus length of the bolts can be removed if you feel the need, for now I would leave them be until you are ready to paint your model traction engine, when all these little niggles can be addressed.

By bolting the tender onto the fire-box, you can now see the shape of your traction engine beginning to materialize.

TENDER FITTINGS

Basically we now need to install the towing hitch on the tender, but to do this the bearings for the rear axle, which the towing straps are attached to, need producing first.

The bearings are a tight fit and pushed through the tender sides from the inside and are held in place with a brass flange, so as you bolt them up, your four bolts go first through the towing strap end on the outside, the tender side, then the bearing flange.

It can be noted here that with this basic model, there are no steps for the 'driver' of this model to be used to climb aboard, as this model is not a copy of any particular traction engine. Also, there is no winding drum (meaning no tow rope rollers/guide needs attaching to the rear of the tender) but you can install these if the urge takes you. Also not included is a differential, just to make life less complicated.

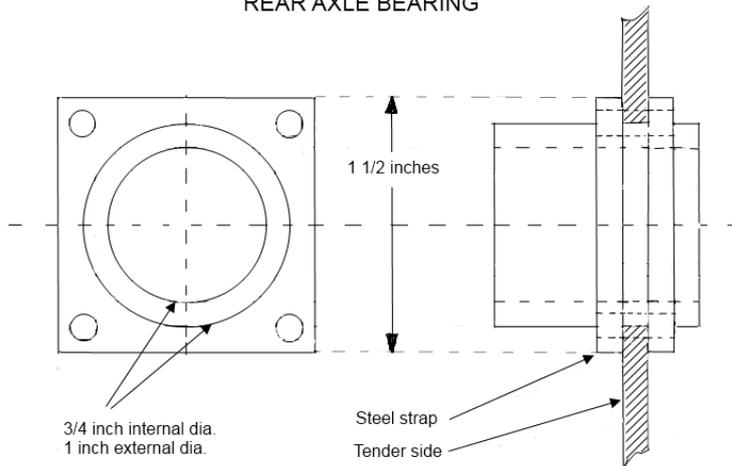
Materials needed for the tender fittings are as follows:

- 2 of 1½ inch (37mm) square brass plates, ⅛ inch (3mm) thick. (*bearing flange plate*)
- 2 of 1 inch (25mm) diameter x 1 inch (25mm) long phosphor bronze rod. (*bearings*)
- 2 of 1½ inch (37mm) x 4 inches (100mm) steel flats x ⅛ inch (3mm) (*towing strap ends*)
- 1 length of ¾ x ⅛ x 16 inches (19 x 3 x 400mm) steel (*towing strap*)
- 1 length of ¾ x ⅛ x 6 inches steel (19 x 3 x 160mm)- (inner re- bracing)
- 1 length of 4 inches x ¾ inch (100 x 19mm) square section steel (*towing hitch*)

The first thing on the agenda is to mark the centre of a 1½ inch square x 1/8 inch (37mm square x 3mm thick) brass plate for a bearing, with a line scribed on one face around the edges at ⅜ inch (5mm) in, and bore a hole through the centre at ⅞ inch (22mm), with the four crossing points of the outside lines bored with old faithful, the 3.6 mm.

Next, install the phosphor bronze rod in your 3 jaw and skim it for ¼ inch (6mm) to be a sliding fit inside that hole. (*If your lathe tools are not sharp, you will need to make the two parts fit together precisely, and the use of a hacksaw blade at the corner where the cut ends will allow the brass plate to butt up to the larger diameter of the phosphor bronze rod, but only turn the chuck by hand while you trim this point if you are using a saw blade. Alternatively, the entry point on the plate can have its corner rounded with the use of a fine file to allow the flush fit.*)

REAR AXLE BEARING



Now you have a single flange completed, the second one can be done in the same manner, although this time the second phosphor bronze rod may need to have a slightly different diameter to fit the hole in the other plate, so each rod and flange will need to be kept paired.

The first rod and flange now need silver soldering together. (*Silver solder is*

being used for the strength required here, although there will be very little heat involved in general running, soft solder simply would fail.)

Stand the rod on the un-machined end in an upright position and slide the flange down the newly cut part and silver solder them together, making sure the flange sits squarely on the butted machined edge. Then repeat for the other bearing.

Next, once they are cleaned up, install one in the 3 jaw once more, but this time with the jaws on the small protruding machined part, and skim very lightly the larger diameter down to 1 inch or until the cut is all round. Next, skim the face of the flange lightly to a nice even cut so that everything is square to the shaft you are creating.

Swap ends in the chuck with the now machined flange face butted up tight to the 3 jaw and skim once again the small 1/8 inch (3mm)^h stub before trimming the face of the flange to square.

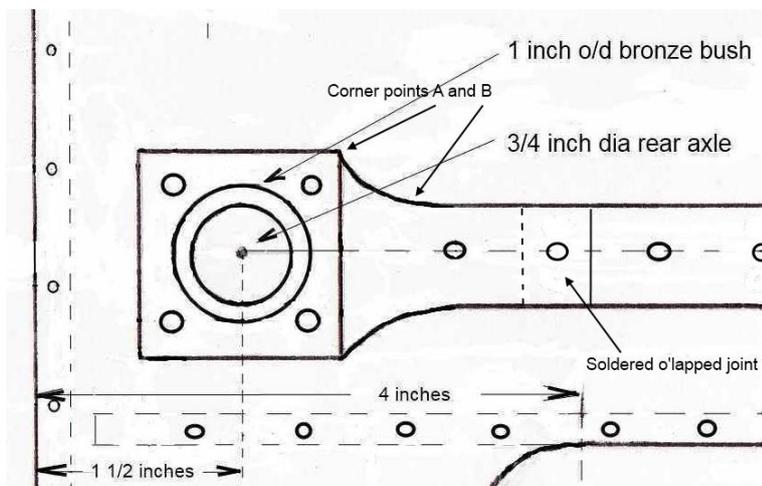
That's all the outside work done, so you now need to centre drill the rod while it is held in the chuck and bore it out to 3/4 inch (19mm) to match the rear axle diameter. The second bearing needs the same treatment.

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On the side plates, at the main axle centre you need to bore this point out to one inch diameter to accept the axle bearing you have just produced, remembering the longer side of the bearing is pushed through the hole in the tender side plate from the inside.

What you are aiming for is to have the main part of the shaft of your bearing able to fit snugly inside this hole, as any slack here forces the weight of your traction engine to be supported solely by eight 4 BA bolts. Not a good idea! If necessary, by boring it slightly undersize, the main diameter of the bearing can be reduced down a little to a snug fit.

Next we come to the towing strap ends, and here a little marking out is needed.



Take one $\frac{1}{8}$ x $1\frac{1}{2}$ x 4 inch (3 x 37 x 100mm) steel flat and square the end off. Mark in $\frac{3}{4}$ inch (19mm) and mark a centre line along its length. Also mark off $1\frac{1}{2}$ inches (38mm) from the squared end.

With the two pieces of the towing strap ends clamped together, the 1 inch hole can be bored for the bearing to enter.

Using each side individually, grip the towing strap end with the

bearing inserted along with the brass edges of your bearing in your vice and drill for the 4 bolt holes using the bearing flange as your guide. What you need here is the face of the towing strap end to be square upon assembly, and also the square head of the bearing.

Once the four holes are complete, the bearing needs inserting from the inside, through the tender side and then through the towing strap end and it is now where you will find the front edge of the bearing needs trimming slightly to get it to sit flush against the tender side.

Once you have it snug and sitting flat, make a point of keeping the towing strap part in a horizontal position and drill through the towing strap part to mark the bolt hole positions on the tender side, then remove the bearing and bore them through.

Mount the bearing through the side panel with the towing strap end on the outside and insert four bolts and check you can tighten them up. I had a few little problems here as the nuts sitting at the front of the bearing were a bit close to the fire-box, but with a bit of persuasion, I got them home.

Once this is satisfactory, strip the parts once again and next you need to shape up the towing strap ends to marry in to the proposed towing straps.

Scribe two arcs from the top and bottom right hand side at the rear – as on the drawing above – between the corner points A and B, to marry in to the two lines you have already marked either side of the centre line at the rear, leaving a $\frac{3}{4}$ inch strap for the rear end. *The easiest way to do this is to use a 2 pence coin, with the edge level with the corner and the line, and scribe around the edge, although I did not use this very simple method at the time myself.*

You now need to remove the surplus to give the shape required on both pieces.

You will need to reduce the thickness of the towing strap stub for a length of half an inch or so, as you are going to overlap this part of the towing strap with the front of the main towing strap side pieces (which needs the same treatment – similar to the rod end arrangement in the fire-box, only straight in line, rather than at right angles.) and silver solder them together, to give the impression

the towing strap is made of one piece, rather than three pieces, but until you know the position of the overlap, that is as far as you can go on this part.

The main towing strap is very simply a flat piece of $\frac{1}{8} \times \frac{3}{4}$ (3 x 19mm) steel flat bar folded around the sides and rear of the tender, secured in place with bolts, and carries the towing hitch on the rear.

Start with a length of flat steel around 16 inches (400mm) long and mark its centre point along its length on the two flat faces. On one side from the mark another one needs to be at 3 inches (150mm). This marks the point that will go around one rear corner of your tender, and will sit on the inside face of the strap.

Place the flat in your vice with the mark sitting level and square with the top of your vice, so you can barely see it. And bend the flat at this point using a heavy hammer to make sure the angle is at 90°. You do not want a rounded corner on the inside of the bend, but rather a clear, sharp angle if possible.

With the strap now mated up to the tender, shorter side forwards, simply mark the flat at the start of the overlap at the other rear corner, and bend that point accordingly.

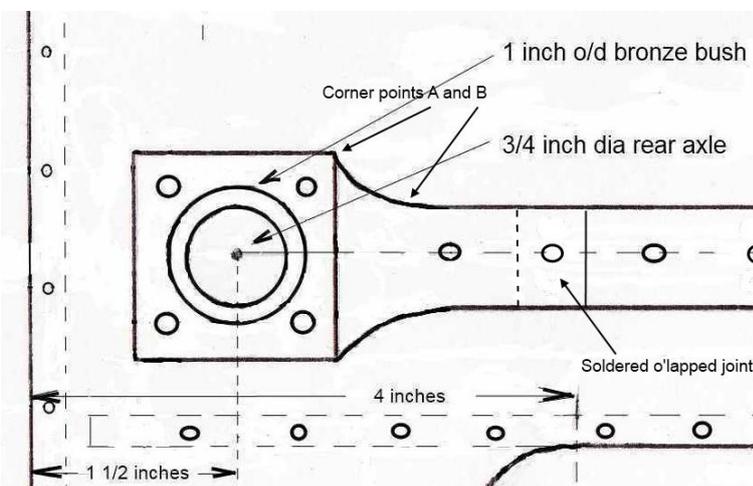
You should now have a flat bottomed 'U' shape towing strap whose arms sit flush with the tender sides, with the base of the 'U' sitting flush with the rear.

What's now needed is to remove the two bolts at the rear of the tender sides, level with the back axle, so the strap can be positioned on the tender to allow marking for those same bolt holes.

Make a mark on the outside face for the full length of the sides of the strap at $\frac{3}{8}$ inch (9.5mm) from the edge, that way giving the centre line and slide it into position on the tender, sitting either above or below the bolt hole so that the point can be marked on the strap.

Drill through on the crossed point with your 3.6mm drill and attach the strap onto the tender.

This is a bit rough and ready, as there is no way to mark this point accurately, unless you want to take the side off the tender and drill through from the inside, using the existing hole as a guide. Having this one hole just a little offset, meaning having to drill it larger to accommodate the bolt, is not too detrimental, as the remainder of the bolts will hold the strap in place properly, and the head



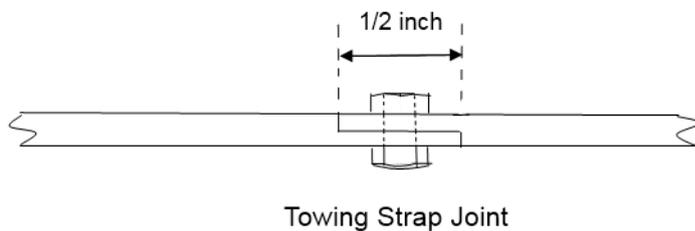
of the bolt will cover the enlarged hole nicely.

Once you have the strap in place, with the centre line of the strap sitting directly along the axle height line, then you can mark forwards from the centre of the bolt at $\frac{3}{4}$ inch (19mm) intervals, to produce your drilling points on the strap.

You will find that the end of the towing strap ends (the part that fits around the axle bearing), when in place, overlaps the side of the towing strap, and what you want here is to have the overlapped area (to be silver soldered together) in a position where a bolt will go through both ends of the mating parts, with at least a ¼ inch (6mm) either side of the bolt for soldering.

On the above picture, the position is shown by the arrow pointing from 'Soldered o'lapped joint', showing the cut marks on the main strap, with the end shown by the hatched line to its left, that way there will be a continuation of the same thickness of the strap from the rear to the axle bearing, meaning the towing strap runs in a straight line, up against the tender side, and with a bolt through the centre.

So once you know where the bolt will be going through, bolt position 5 or 6 is fine from the rear of the tender, simply cut the towing straps a ¼ inch (6mm) longer than the chosen position and square the end off. The towing strap end (the part that fits over the axle bearing) needs to be placed over the bearing to give the length to that same bolt centre plus ¼ inch (6mm).



All ends on the three pieces of the towing strap now need half their thickness filing off for a length of ½ inch (12mm) to give a nice even surface for the silver solder to be

applied to.

The picture above gives an idea of what is needed as viewed from above, with the bolt going through the centre of the joint, although the bolt will also be going through the tender side (not shown).

Once you know the positions of the bolts – at approximately ¾ inch (19mm) centres along the towing strap, having centre punched them, then you can drill the overlapped joint and bolt it together with a brass bolt and only finger tight to allow silver soldering. The brass needs to be removed once the soldering is done, and the easiest way is to file off any nut or bolt head, then assemble it all together and drill through the side of your strap and panel using the centre punch marks as your guide.

On the joint your drill will follow the existing hole, that way removing the remnants of the brass bolt.

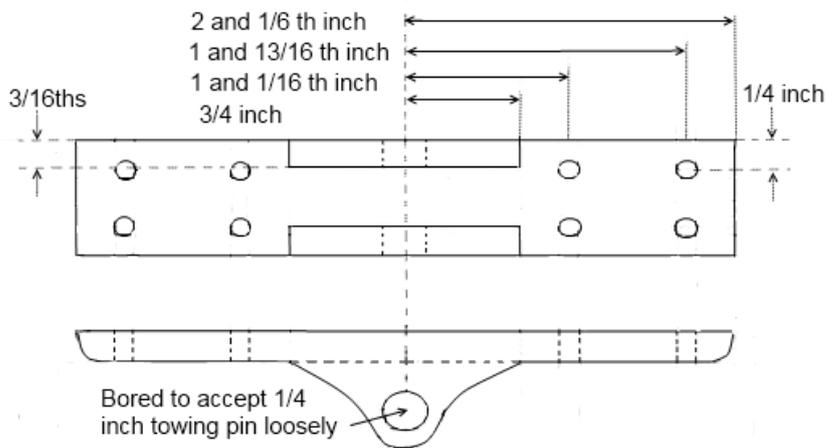
Bolt it all together, along with inserting the bearings and their bolts.

The towing hitch.

This is a very simple piece to make and starts off as a ¾ inch (19mm) square steel rod.

Make one end square and mark a length off at 4½ inches (105mm).

On the front face (the part against the towing strap) all the marking out can be done for the boring of the 4ba bolts at $\frac{1}{4}$ inch (6mm) from the long edges, along with a centre line for the position of the towing pin hole. Once you have this centre line marked, continue it with a square around the faces to the top face. From the front face you need to mark a point at $\frac{7}{16}$ inch (11mm). This needs centre



punching and an arc drawn at $\frac{5}{16}$ inch (8mm) from this point to provide contact points for the chamfered hitch sides, before drilling through with a $\frac{17}{64}$ inch (6.75mm) drill – *If you don't have one, then use a $\frac{1}{4}$ inch (6mm) and the towing pin can be skimmed slightly to allow the necessary*

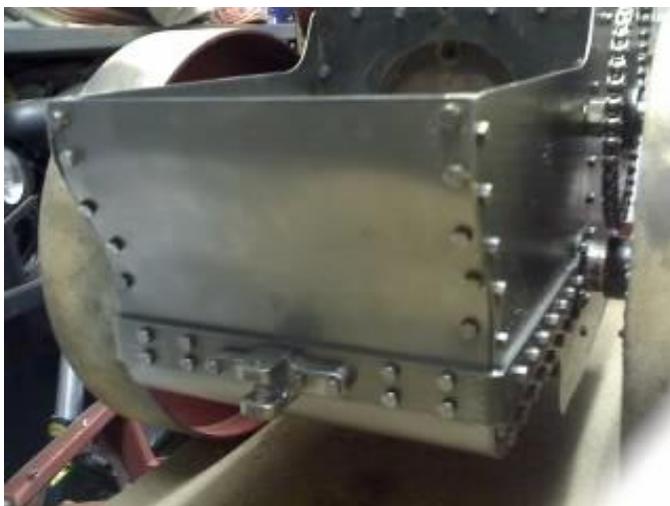
clearance.

Once you have bored the 4ba holes, all the drilling work is done and you now move onto the rear face (the shaped part facing the proposed trailer).

The plate section that bolts to the towing strap is $\frac{3}{16}$ (5mm) thick. As are the lugs at the top and bottom that the pin slides through, so lines will need to be marked on both the top and bottom face from the front face to show the finished depth of the metal.

You now need your hacksaw to remove the rear outer unwanted sections before removing the bulk of the centre where the trailer hitch sits and finally completing the shape with a file.

All the outer corners are rounded off a little for safety's sake, as this is a position where your hands will be frequently.



*This picture is of BERNIE, my second attempt, and shows the draw strap in place and the towing hitch being a little on the small side, but gives a rough idea of what it entails. The **PYRTE** version is much wider, giving much more rigidity and more bolts securing the hitch to the draw strap.*

The next part is to install it on the draw strap and the tender rear, so locate the middle of the rear end of your draw strap and line it up with the centre line of the

hitch, making sure it is sitting levelly and centrally, and drill the strap and tender rear with your 3.6mm drill, using two of the end holes (one at each end) in the towing hitch as a guide.

You will be wise to use a second piece of the draw strap bar as a re-enforcing (bracing) rod that sits inside the tender, that way keeping the rear end of the tender a bit more rigid.

This part needs to be inserted between the two ¼ inch (6mm) steel lengths of corner bracing sitting inside the tender and against the rear. It first of all needs the length trimming to fit the gap (should be 6 inches less 2 x ¼ inches = 5½ inches (138mm), but may need a little extra off owing to building tolerances).

What you need is a little play to give an easy fit and then the centre line on one face marking.

With the towing bracket sitting on top of this brace, with the two centre lines matching and their top faces level, the same holes used for drilling the rear of the towing strap can be used to drill a couple of holes with the 3.6mm drill, again using the towing hitch as a guide.

With this done, mount the towing hitch against the towing strap, against the rear of the tender, with the brace inside the tender, and insert two bolts through these holes.

Nut them up tightly and drill the remaining holes using the towing hitch as your guide. Bolt them all up now, so that the complete back-end is secure.

The bolts may appear a bit long at the moment, but leave them be for now.

That now concludes the building of the tender and its fittings, other than the water tank, which is dealt with later, so the next topic is at the front end, the smoke-box.