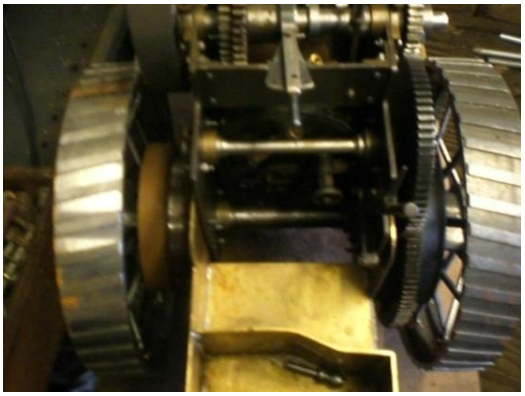
Building Rear Wheels for a Traction Engine

Building proper rear wheels for a traction engine like **PYRTE** with spokes rather than solid wheel centres as the simpler version explains, along with strakes sitting on the outside of the rim to provide extra grip takes a little more effort on the part of the builder, but can improve the appearance of any traction engine considerably.

In fact there are two tedious operations in producing these wheels. The more mind-numbing is making and fitting the spokes; the second is the strakes.

The operation, from start to finish for each wheel, should take around five or six hours as there is a lot of repetitive work involved.

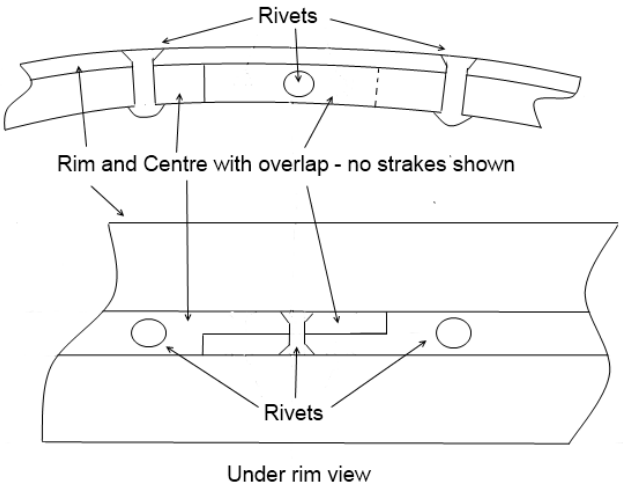


The strakes are simply ¼ x ⅛ strips of steel that sit on the outside of the rim at around a 15° angle to the axle as can be seen in the picture looking towards the front of the engine, and their purpose, besides allowing more grip, is to push the wheels towards the centre of the engine as more tractive effort is applied, that way not ripping the wheels away from the axle and the centre of the engine when most power is needed.

Obviously, the bulk of the driving is done in a forwards direction, so the strakes need the leading corner on the inside hitting the floor first.

It is a little confusing this description as you tend to view the strakes from above and are used to seeing them with the leading corner showing on the inside as you can see with this model 1.5 inch scale being completed and you also need to remember that they are ‘handed’ to suit each rear wheel when assembling.

There are 32 strakes per wheel on **PYRTE**, just to make the divisions easier, and each is a little over two inches long owing to the angular ends needed.



Under rim view

Installing a smooth wheel

So, starting at the beginning, I am assuming you have the 2 inch wide by 10 inch diameter rim cut from a gas bottle as was specified in the original build.

Firstly there needs to be a rim centre fixed to the inside of the rim before the spokes can be attached. This is needed regardless of whether you want strakes adding or you want to be running on a smooth rim, or have glued-on tyres.

What we will do first is to produce a smooth rimmed wheel, then the strakes will be added, before finally moving on to the hubs and spokes.

You actually want 8 points to attach the rim centre with rivets for the smooth wheel, so it is a matter of dividing the rim into 8 equal sections. Next, on each rim, you need a centre line running around the outside circumference to show where the drilling points lie to attach the rim centre, along with two marks on the inside of the rim to show where the edges of the rim centre sits and these dimensions will need to be adjusted to what material you use.

At the 8 crossing points of the centre line, drill through the rim with a ⅛ drill, before using a ⅜ to countersink a little to provide a head for your rivet, as per the drawing. The surplus will be filed off once the ring is riveted in place to produce a smooth finish to match the outside wheel rim.

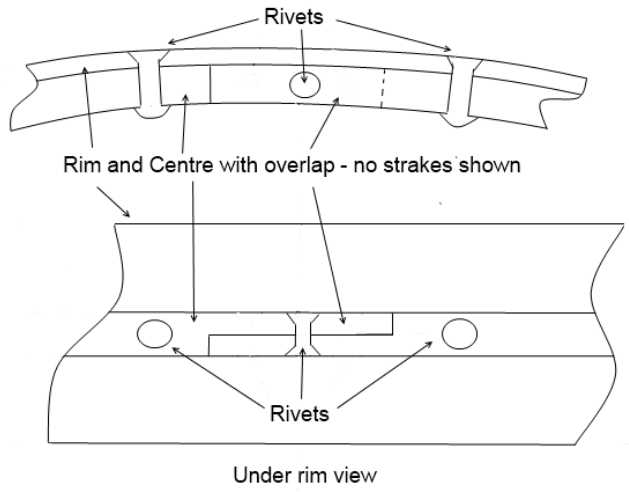
The rim centre is a single piece of steel, unlike this commercially produced rim having two webs along the inside of the rim - but the principal is the same, at ⅜ square and a little under 3 feet long (you can use thinner section if you wish providing you are accurate enough with your drilling, as this requires a fair bit of force to bend it to shape, even with heat).

The ends of the rim centre should be cut back along their length by one inch to provide an overlap, much like the towing strap had, to give the impression of a single ring being inserted inside the rim as in the not-to-scale drawing below.

An easy option for the bending of your rim centre would be to bend it round the gas bottle itself (or whatever you have left of it if you have already cut the rims off).

This will give a circular shape just a little larger than you need, but by doing it this way you will bend the rim centre uniformally, that way causing no unnecessary stress on the parts.

What you need now is to force the circle into the inside of your rim, preferably just inside one edge, so that with the centre being oversize it will try to push the rim outwards and this means the contact is very close which is something we need to allow the surplus length to be removed.



Under rim view

By cutting the length to allow a 1 inch overlap you need to cut back along each end for 1 inch to provide a tongue for half the thickness of your rim centre so that the two mating ends overlap and provide a continuous rim centre of the same thickness underneath the rim once you have

trimmed the ends.

You now need to slip the ring in to the central position you had marked inside the rim, with the joint sitting just to one side of one of the eight holes, and a hole drilling at ⅛ through one of the 8 points for both the rim and the ring. It is suggested you use a nut and bolt to temporarily hold the parts together until all eight points are bolted in the same manner.

Once the holes are lined up, it is just a case of replacing the bolts with ¾ inch length x ⅛ soft iron rivets. The rivets are pushed through underneath and up through the rim so that the rounded head is showing nearer the wheel centre, while the top is standing proud by around ¼ inch from the rim for the smooth wheel.

All that's need now is to support the rim on the top of a ⅛ rivet snap (a bit like a centre punch with a hollow head matching the shape of the rivet head) sat in your vice and clout the top end of the rivet to flatten it out to fill the drilled hole in the rim. Do make a point of working round your rim one rivet at a time and then make a second pass round with the clouting.

The joint in the rim centre now needs a ⅛ hole drilling centrally through the overlap and a ⅛ rivet inserting to fasten them together, and to accomplish this the outsides of the holes should be widened a little, just like you did on the rim, so that you have a void at each end of the hole for the rivet to fill, and with the head sawn off the rivet, this can be used to hold the ends of the rim centre together.

The two parts, the rim and its inner ring, are first riveted together using ¾ x ⅛ inch diameter soft iron rivets along the eight points for the smooth wheel before being soft soldered to make the joint more secure, or if you have a welder, so much the better.

If you go down the welding route, be prepared to have to remove some of the weld to allow room for the spoke heads to sit against the rim.

The easiest option is to fix the spokes in place before running in your soft solder.

Installing the rim centre with strakes

This follows almost the same path as the smooth rim construction, but here we need to do a little extra marking out and to proceed a little differently.

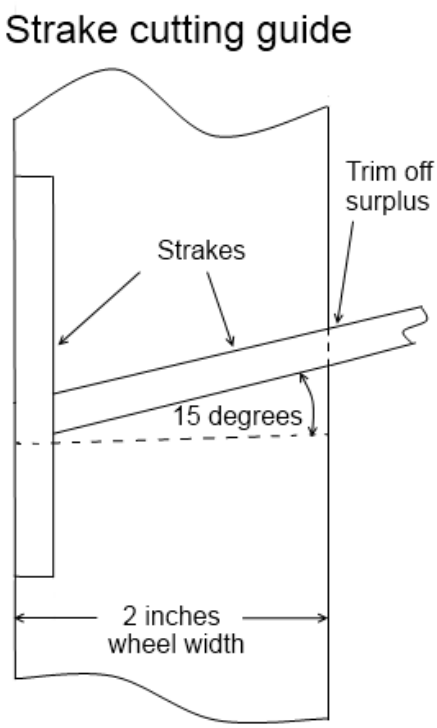
The rims need dividing into 32 equal sections which can be done with the paper method, but for this you will need a sheet of 32 inches minimum in length for the 10 inch (25cm) diameter wheel rim on **PYRTE**.

Start off by marking these 32 points on one edge of the outside of the rim and a line needs marking along the outside of the rim at 15° from these points if you have the necessary bevel gauge. If not, an easier alternative works just as well, but is just a nadgers out, in that from those same marks using a square scribe a line across the outside of the rim for each mark.

On the opposite edge you then need to mark at ½ inch intervals from those lines (not forgetting that the two wheel rims are handed - meaning the leading edges you are marking now need to be in front of the line and must sit opposite to one another for each rim).

Once you have the ½ inch marks, then the 32 lines need scribing from the ½ inch mark to the opposite side where the original mark started across each rim to denote the angular position of your strakes.

Next you need to make a mark around each rim at ⅛ of an inch in from the edges right round the circumference on both sides, along with a central line around the circumference. What this has done is to give you the positions of the outside edges of your strakes and the central drilling positions.



You now need to make the strakes themselves and this is achieved by taking a 2 inch x ⅛ flat section of steel from your scrap bin, anything over 3 inches long is fine providing it has the 2 inch width, and scribe a line at right angles to the longer face roughly in the centre. From the end of this line you need to produce the same angle you had on your wheel rim, whether by the ½ inch method or the bevel gauge method. Do not worry which way round you angle this as the strakes can be turned over to produce the opposite handed strips.

Take a 2½ inch length of your ¼ x ⅛ steel strake section and lay it flush along that line with an end just overhanging before marking the underside at the overlap point on one side. Take off the angled end and trim the strake up with a file.

By clamping a spare strake section to the edge of your 2 inch wide steel, you can lay the strake against the spare with its cut end sitting flush with the spare and lying along the angled line on the rim. The strake again needs marking on the overlap point and the surplus removing.

What this has done is to give you one strake of the correct length to suit your rim at the chosen angle.

All that's needed now is to produce another 63 (plus an extra four or five as spares).

A simple jig is all that's needed to produce many at a time using one as the guide.

Once completed, scribe a line along the centre of each one and marks need making at ⅜ of an inch from the end points at both ends to cross this line. Centre pop these points and drill through with a ⅛ drill.

A further line needs marking at the centre of the strake length on all the strakes to allow you to drill for the central rivet at ⅛ diameter. This is best accomplished by laying the strakes on your rim and sitting at the angle chosen, with the edges in line with the ⅛ outer marks already scribed on your rim, then make a mark in line with the centre line running around your rim.

Drill the central holes in these strakes first before placing them on your rim, front edge lined up with the angled lines and the edges again in line with the ⅛ outer lines and drill through your rim using the strakes as a guide on each fourth strake, marking each underneath to make sure you can put them back on the rim to the place they were drilled through. Obviously doing them one at a time and keeping them in place with a small nut and bolt temporarily will do the trick.

Next you need to countersink each of the three holes in the strakes, but half need to be done on one side with the other half on the other. The best option here is to do the countersinking on only eight strakes so that you get this the right way round, and only dealing with one wheel at a time.

With the wheel inner ring cut to size and in position as above, the three parts, the strake, the rim and its inner ring, are first riveted together along every fourth point, by lining up the strake with the front face lying along the angled line and the edges level with the outer marks on your rim and drilling through all three with a ⅛ drill for the rivet.

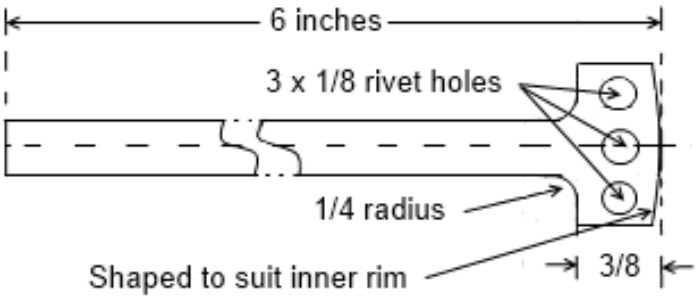
Because of the extra depth of the strake, you will need to use 1 inch long rivets here.

Attach the central rivets first to check the spacing is right before attaching the outer ones for the 8 using ½ inch long rivets with the heads sitting underneath as before. Once you are happy with those, the remaining 24 can be attached and the surplus from the rivet shaft filed off flush.

It should be noted that the strakes, being flat, will not sit close to the curve of the rim, so need a slight twist with pliers to get them to sit down flush.

And now the spokes...

Spokes are generally a pain to produce as they start off as a length of ¾ x ⅛ flat steel at 6 inches long (the longest are just a nadgers over 5¼ inches) and these also need to be bent in certain places, some shorter than others, as well as some having a twist in their stem, but using the 6 inch length covers the lot.



You need 16 for each wheel and each has a stem of ¼ wide with a head at ¾ inches.

Start off with your 6 x ¾ x ⅛ steel section by squaring one end and mark a line down the centre for the full length. You now need two more lines on either side of that at ⅛ for the stem and two more at the squared end to mark the rivet holes as we will be using 3 rivets per spoke. at ⅛ diameter. (You can use smaller diametered rivets here if you wish, but don't go below $^3/_{32}$ as they will fail, especially if you decide to use copper rivets on the wheels.)

The top of the spoke head needs to be shaped so it is a snug fit against the inside of the wheel rim. Once the end is shaped, a line can be marked parallel to the shaped end at $^3/_{16}$ in to

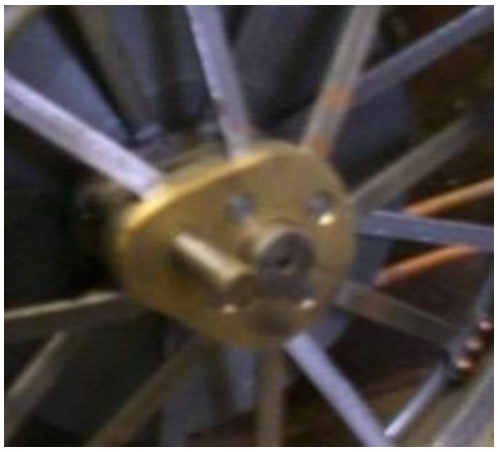
denote the lines for the rivet holes. All that's needed now is to drill one in the centre where it crosses the centre line, with the other two at ¼ inches away on either side. This gives an evenly spaced mounting and also allows room for the rivet heads to be seen on the outside of the wheel.

Once you have the spokes shaped, then you need to move on to producing the hub.

HUBS

A simple way to produce these is to build them up in sections and solder them together with the spokes in place.

For this, you will need 4 pieces of brass at ⅛ x 1¾ wide and 2½ inches long, with a fifth at ½ x 1¾ wide and 2½ inches long per hub.

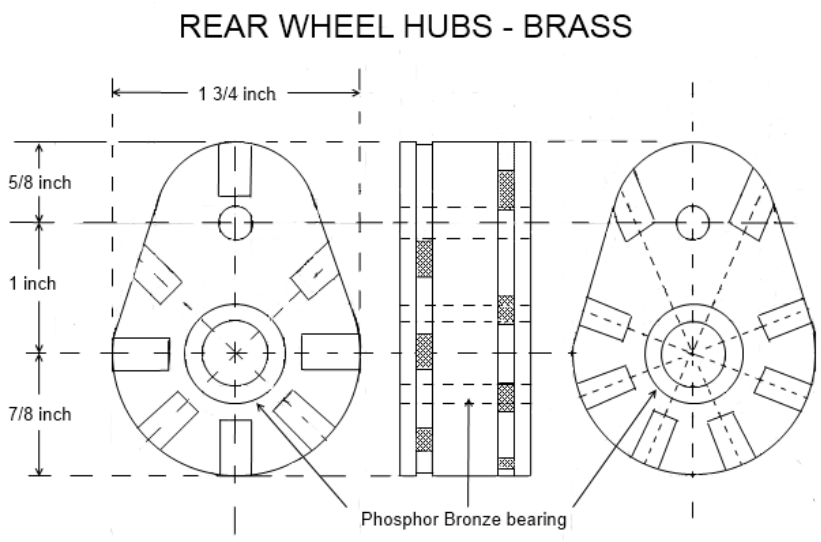


This picture (from the earlier engine shown above) gives you an idea of the shape, allowing the drive pin (a temporary one sticking out of the side) to be engaged fully for drive purposes.

This wheel shows a steel centre with a brass outside and these are riveted together, but we are aiming at a far simpler method of construction.

The way we will do this is to have it made from sheet brass, the outside parts solid, with the next two parts working towards the centre, having the slots cut into their edges for the spokes, and the final ½ inch central part being solid and sitting in the middle.

These five plates are shaped together, with the two spoke plates shaped individually as the slots are a little offset to each other as can be seen in the drawing, and they are soft soldered together along with the spoke ends once the wheel and hub are built up. It can be silver soldered if you wish, but soft soldering is much easier to accomplish and does the job



admirably.

A further securing method can be included with the soft soldering method of drilling a $^{1}/_{16}$ hole in each spoke end at ¼ from the end and centrally along its width, with a matching hole drilled in the inner hub (½ inch hub) for a depth of ⅜ an inch and a $^{1}/_{16}$ pin inserting through the spoke and sitting flush with the outside face of the spoke, so that the outer cover will keep the spoke and pin in place once soldered.

Using the pins in this way also allows you to set the spokes correctly first before any heating up is done for the final soldering.

There is a ½ inch depth allowed for the end of the spokes to be secured, and the main axle hole is as before, ¾ inches diameter to allow for the 1 inch long phosphor bronze bearing to be installed, which is drilled at ½ an inch to allow the axle through. The driving pin hole is ¼ inch and needs to be bored right through, like the bearing hole, once the hub is assembled.

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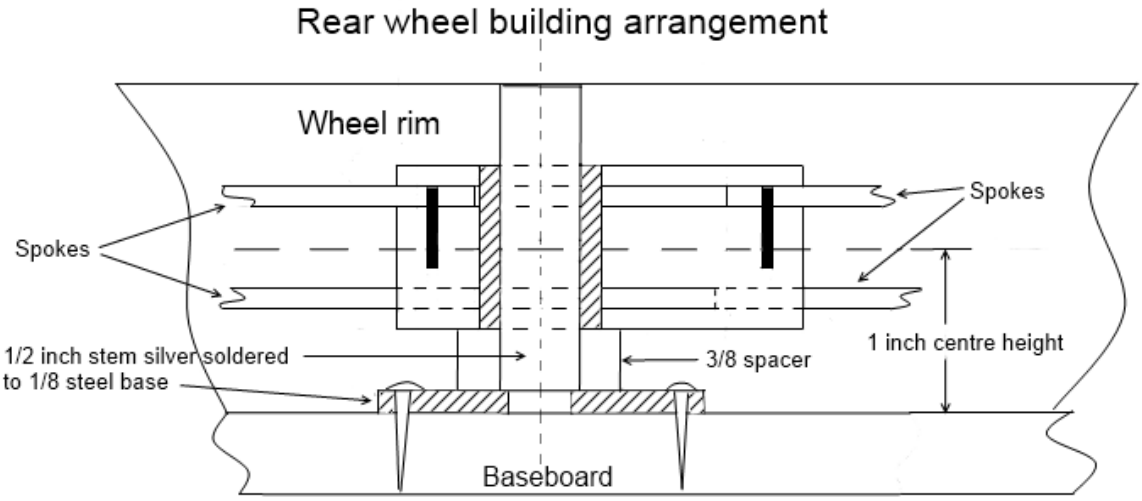
Right, you've got your rims sorted with the inner rib and strakes, your spokes cut and the hubs ready, so what you need now is a way to fasten them all together to produce the complete wheels.

The wheel and hub are assembled in exactly the same manner as the plate centred wheels were, but need to be mounted a little differently.



The same ½ inch diameter pillar is soldered to a ⅛ plate as before and this time a ⅜ thick packing piece is required to raise the centre of the hub to one inch high from the baseboard surface. You will notice the positions of 2 black $^{1}/_{16}$ pins showing to secure the upper spokes in place, along with the phosphor bronze bush around the ½ inch diametered stem.

The wheel rim needs centralising in the same was as already described (don't forget to allow for the extra thickness of your strakes with the securing pins), and what we do here is to

place the inside plate on first (working from the right hand side in the drawing above but one), then the odd angled slotted plate (this sits on the inside of the hub towards the middle of the traction engine), then the centre, with the outer slotted plate next.

As you have already divided the rim into 32, you need to place 8 spokes around the inner rib with their heads sitting against the underside of the rim and the first needs placing just to one side of the rivet that joins the two ends of the overlap of the inner ring.

What we are aiming for is to have at least one rivet of 1 spoke being placed through this joint to give extra support to the joint. This sets up the position of the first spoke and from this the position of the other 8 can be determined.

You now need to drill through the inner rib sideways in line with the centre rivet hole in the spoke head for each spoke, and attach every other one. The reason for this is that you will need to twist 2 of the other spokes before they are installed, but also with the four straightest in place, the hub and wheel can be turned over and a start made on the opposite side, that way allowing the wheel rim to sit correctly with the hub.

With these four spokes, they will need the heads bending slightly so they sit flush with the side of the inner rib with the shank of the spoke resting on the edge of the slot it needs to be sat in.

From this you can determine the length needed for your spoke by adding ½ an inch from the contact point, trimming the end off, and bending the spoke at that contact point so it lines up with the face of the slotted plate. What you want is to be able to place the final outer plate on top and the spoke should not be keeping it proud of the surface.

It is wisest to start off with the two opposite spokes at ¼ to and ¼ past on the hub (with the longer side being at 12 o'clock) as these are the easiest to begin with. From there you move on to the half past and o'clock positions, attaching the spoke heads first as you do so, with a single central nut and bolt pinched tight.

Once you have these four spokes in place it is best to tin the bottom of the spokes, along with the central hub side of the slot the spoke sits in and apply a small amount of heat to just secure the spokes in place, turn the whole wheel and hub over and with the wheel centre at the same height, install 4 other spokes on the other side in the same manner, again at 90° intervals.

With the eight spokes secured by a single rivet to the inner rib and a bolt through the centre with two washers to keep the outer hub plates in place, you can now spin the wheel and true it up before adding any other spokes.

If you add the spokes first you will find the whole wheel will be too rigid to manipulate the rim and hub, so you may finish up with a wobbling wheel. Once you are happy with that, then it is a case of installing the other spokes and tightening the rivets in place.

The spokes on the lobe end of the hub require some twisting, as well as bending, to get them in place, so you may need to thin the width a little on certain spokes to get then in the slots.

With that completed, you can now drill through the rib, using the remaining holes in the spoke heads as guides, to give rivet holes for the remainder.

If you want to go down the extra $^{1}/_{16}$ securing pin route, then now is the time to add those pins.

You will see that so far the outer hub plates have not been attached, so they should be tinned on the inside and soft soldered in place, before checking the wheel rim position sits centrally when spun on the axle.

Finally, the wheels and hubs can be mounted in exactly the same way as described for the original wheels along with the hub caps attached in the same way.

That just about concludes the 'better - more normal' rear wheel build for **PYRTE**.

If you want to know more about building this very simple **P**ull **Y**ou **R**ound **T**raction **E**ngine, please visit http://www.steamshed.com where the original plans and construction guide are available in pdf format, along with pictures of the build in progress.

Greame and George