Building a simple Pot boiler

By Thor Hansen

A friend of mine managed to source some 18-gauge 3 in. dia. seamless copper tube so we decided to try and make a simple pot boiler from it. We also managed to find some 1.5mm (about 16 gauge) copper plate for the endplates and some bronze for the bushes and stays. Many thanks to Graham Meek for his advice and encouragement.

Endplate former

The endplates were cut from the copper plate with a hacksaw. To form the endplates so they would fit into the copper tube a *former* was made. The former was made from two parts – one 35mm dia. mild steel rod about 25mm long and a piece of 12mm thick mild steel about 80 x 80mm. The corners were hacksawed off the 12mm thick steel and three countersunk M6 screws used to attach the two parts together so the former could be turned to dimensions on the lathe – right photo.

The diameter of the former is the inner diameter of the copper tube minus twice the thickness of the endplates.

I realised that if I could make another disc with a centre hole, I could press the endplate between the two discs and spin the endplates to the correct shape. So I made another disc (same dia.) from the same 12mm mild steel material I had, and mounted it the same way so I could turn it to the correct shape and drill a centre hole – right photo.

On a piece of cardboard a 24mm dia circle was drawn and three points marked out 120 deg. apart. This was used as a template to drill three 3.3mm holes in the endplate former, the holes were then tapped M4. Three grub screws were inserted in the holes, protruding about 1.5mm.

I decided to mount a small 10mm ID ball bearing on a bracket that would fit my tool-holder and use the ball bearing to form the endplate in the lathe. To make sure the ball bearing wouldn't rub on the side of the bracket, it was mounted on the faceplate and turned down a mm or so – right photo.

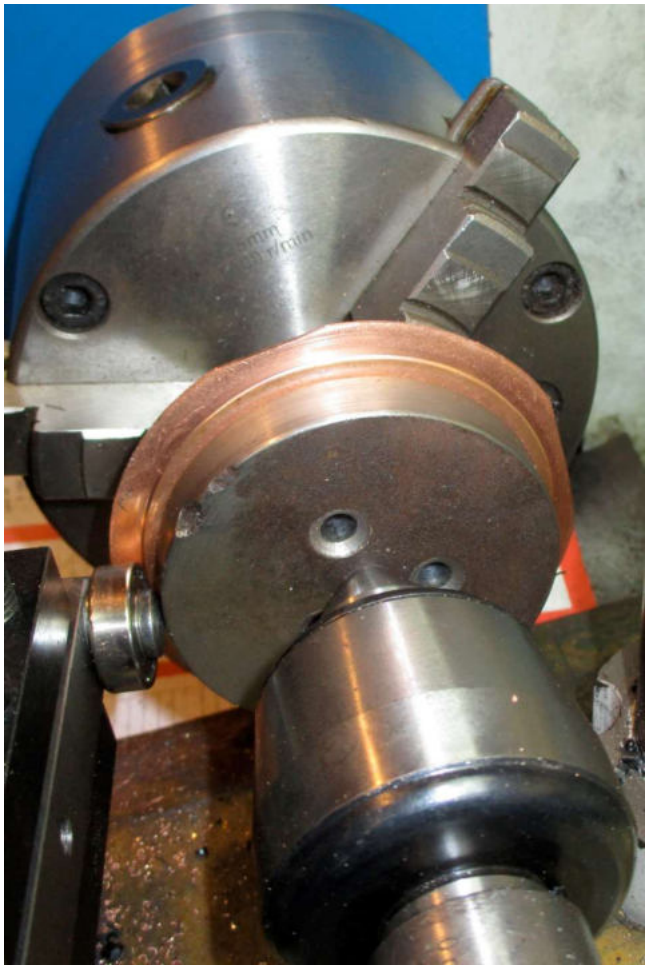
The ball bearing was mounted on a 10mm bolt screwed into the bracket.

Spinning the endplates

The endplates were made larger than the inner diameter of the copper tube, about 6.5mm larger all around. A suitable square was cut from the 1.5mm thick copper plate and the corners sawed off. Since I planned to have three stays I drilled 3 holes in the copper plate using the cardboard template I made earlier. The grub screws in the endplate former would now both centre the copperplate and drive the plate. First the endplate was turned circular – right photo.

Next, the ball bearing spinning tool was mounted in the tool holder and the first step in forming the endplate started. Then the endplate was removed from the lathe and heated to red with a propane torch to soften the copper. After it cooled, the endplate was mounted in the lathe again and the spinning continued. About four heating – cooling and spinning cycles were necessary to form the endplate.

After spinning the endplate was slightly oversize so it was turned on the outside – photo below:



After turning the endplate fitted well into the copper tube – right photo.
I made two endplates this way.

Bushes

I wanted to be able to mount a water gauge, so I drilled two holes in one of the endplates and made two bronze bushes. The small bushes were threaded ¼" x 32 TPI (ME thread) – right photo.
I also made two larger bronze bushes, for the boiler barrel, they were threaded 1/8" x 28 TPI BSP. 1/8” BSP Tees and knees are readily available where I live.

Stays

I used 4mm bronze rods for the stays. They were threaded M4 each end and I just made some small copper nuts to be used on the inside and some larger brass nuts to be used on the outside.

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Soldering plugs

To protect the thread in the bushes when silver soldering (brazing) the boiler, I made mild steel plugs. A square was milled on the plug heads so I could use a spanner if the plugs were difficult to remove after soldering.

Keeping things in place

Before silver soldering I decided to drill three 1.6mm holes 120 deg. apart in the boiler barrel and the endplate with two small holes for the ¼ " x 32 TPI bushes. I could then insert some small pieces of 1.8mm copper wire threaded M2 to keep the endplate and bushes and stays aligned during the heating – right photo.

Before soldering the bushes I got a tip on how to prevent the bushes from falling out during soldering of the rest of the boiler. I turned a piece of mild steel rod hemispherical and used a hammer to widen the part of the bush on the inside so it could still be turned but not fall out – left photo.

The right photo shows the tool mounted in the vice.

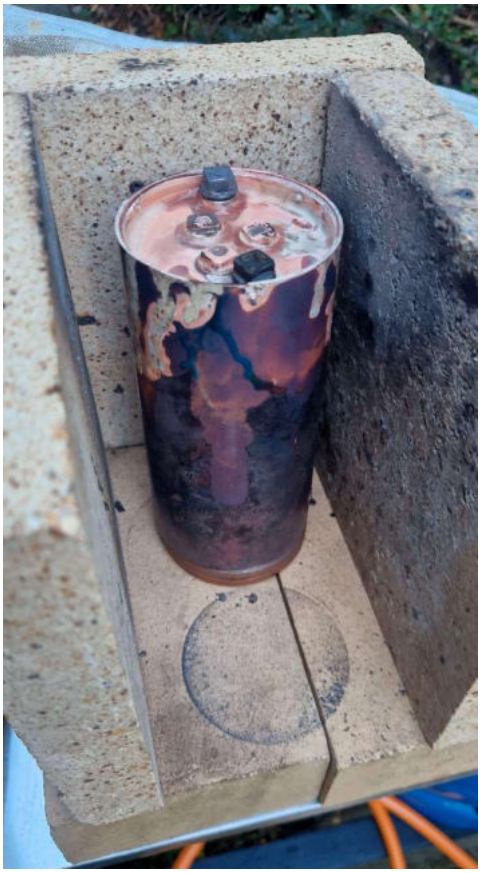
A similar approach was done on the small bushes but I could use a ball peen hammer. I used some packing between the soldering plug and the bush to protect the surface.

Silver soldering (brazing)

The first job was to silver solder (braze) the two large bushes. I used a 55% silver solder brazing rod, a high temperature flux and my Sievert Promatic propane torch. The brazing was done in a makeshift hearth made of firebricks.

The two large bushes were fluxed well and the barrel placed in the hearth and heated until the silver solder flowed into the gaps.

The right photo shows the result.



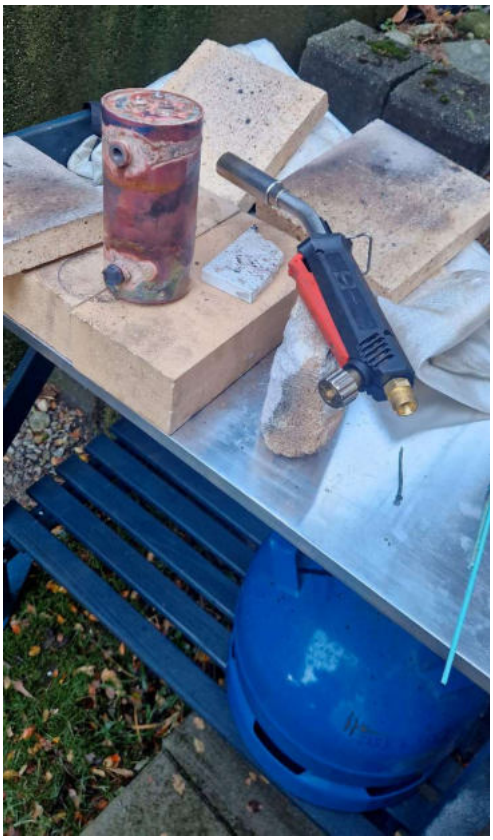
After the first brazing, the inside end of the barrel was cleaned with emery cloth and the already brazed bushes got some new flux. The endplate and stays were fluxed and placed in the hearth and brazed – left photo. The top cover of the hearth has been removed.

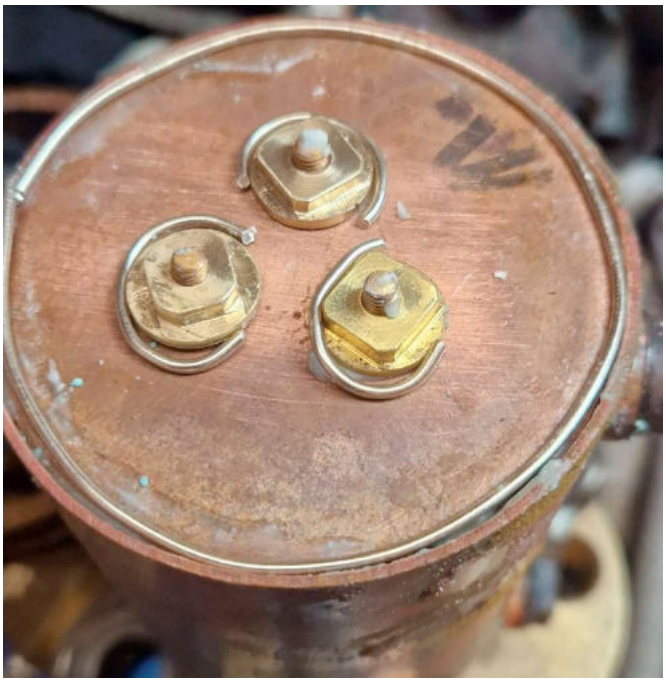
The second endplate was used to hold the stays in the correct position at the other end of the barrel.

The right photo shows the penetration of the silver solder.

The other end of the barrel was cleaned with emery cloth and all the brazed parts fluxed again.

After cleaning the second endplate and stays and nuts were fluxed and some silver solder rod placed around the gaps to be soldered– right photo. When the temperature was high enough more silver soldering rod was applied.





The left photo shows the brazed barrel cooling down. After cooling it was pickled in Citric Acid solution and washed with water.

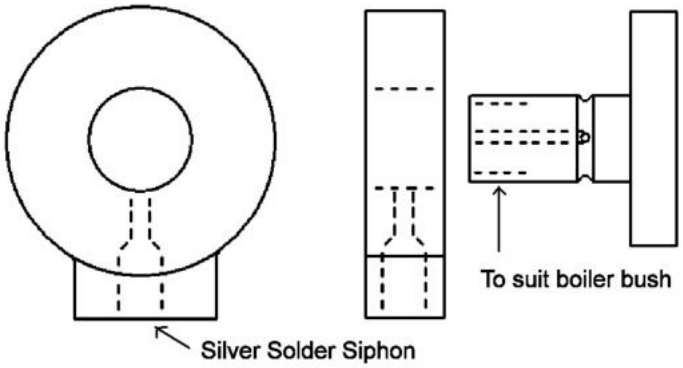
When the boiler was cool enough to handle it was filled with water to see if there was any leaks – none found.

Pressure Gauge Siphon

To be able to test the boiler a pressure gauge needs to be connected. I had an old pressure gauge from a compressor regulator and decided to try and connect this to the boiler.

First I made a simple tube bender to bend the U form of the siphon, then I used a piece of brass to make a threaded connection for the pressure gauge connection and a suitable hole in the other end for silver soldering (brazing) the siphon – right photo.

For the other end (connecting to the boiler) another piece of brass was machined according to the sketch below.



The semi-circular part was milled on a rotary table – right photo. And then silver soldered (brazed) to the siphon.

After pickling the pressure gauge and siphon was connected to the boiler – left photo.

Boiler cladding

After pressure testing – up to 5 bar on the cheap pressure gauge – we started work on the boiler cladding or "housing".

A potboiler isn't very efficient so covering the boiler so that the heat from the burner reaches as much of the copper tube as possible will improve the efficiency.

I already had some sheet metal pieces I could use for the ends and managed to source a piece of stainless steel sheet metal for a roof. I first used some thick paper to make a model so I could get the holes placed in the right place.

The photo to the right shows one end piece with a cut out for the burner.

The next job was to mark out the holes for a water gauge and the pressure gauge and drill some holes – right photo.

The hole for the pressure gauge needed a bit of filing to make it possible to get the silver soldered (brazed) end through.

Below are the two endplates.

I drilled a few 2.5mm holes and tapped them M3 so it would be possible to clamp the parts together.

The rest of the boiler cladding was made from stainless steel. I drilled the holes for the two main bushes and a slightly smaller hole for the chimney before bending. This made it difficult getting a smooth curve, I don't know how easy it would have been to drill the holes after bending.

The right photo shows two parts mounted.

To make stronger threads in the endplates I silver soldered (brazed) some pieces of brass to the rear side of the mounting holes and drilled and tapped M3 again. While the parts cooled after brazing I applied some linseed oil to blacken the endplates and provide some corrosion resistance – right photo. The photo also shows the burner I'm using to heat the water in the boiler.

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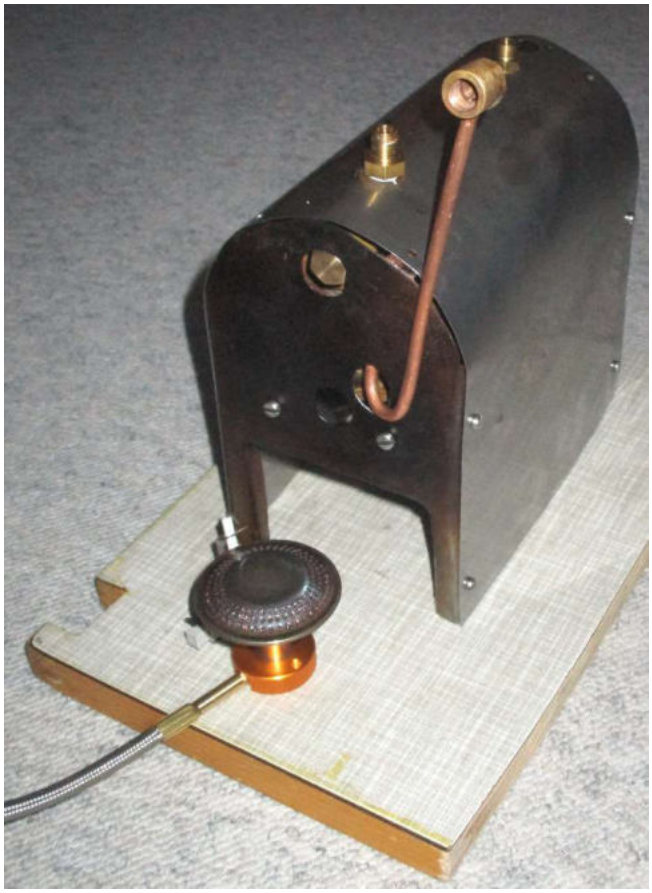

After mounting the various parts on the boiler I filled it with 150ml of water and lit the burner. It took a few minutes before the water started boiling and the pressure rose to 2 bar, and then the safety valves opened and the pressure stayed at 2 bar.

I bent a short piece of copper tube and silver soldered (brazed) on a nipple at one end and a flange to suit my steam engine at the other end (I remembered to put on the nut first) – see photo below. After the cylinder had warmed up the engine ran well and I could adjust the speed by adjusting the burner.