

Steel-Cylinder Slidevalve Steam Engine

By Thor Hansen

After making a single cylinder slide valve engine with a rectangular Cast Iron cylinder I decided to try and make a similar engine with a cylinder fabricated from various pieces of steel I had in my scrap box. Steel isn't as dirty to machine as CI. Most parts were made the same as the previous slide valve engine. Many thanks to Graham Meek for his advice.

Materials

I had a 20mm dia. piece of mild steel in my scrap box and used that to make the cylinder, the port block was made from a piece of hexagonal leaded free-cutting steel. I also parted off two discs from a piece of 30mm dia. mild steel, and used a few other mild steel pieces from my scrap box. A few pieces of brass and some screws and nuts were bought; the rest was mild steel from my box of scrap.

Crankshaft

The Crankshaft was made from 8mm dia. bright mild steel rod and a piece of 6mm thick black mild steel plate I found in my scrap box. I used a hacksaw to get the web piece roughly to dimension and drilled a 7.8mm hole in the centre. The end of the crankshaft was turned down to a press fit in the 7.8mm hole in the web. I placed a drop of anaerobic glue in the hole before pressing in the crankshaft. After the glue had cured the assembled crankshaft was mounted in the lathe and I skimmed the front of the web. The work was then transferred to the milling machine. I used Stevenson's ER-32 block to hold the crankshaft



and using the dials on the handwheels I could drill the hole for the crankpin with a 9.5mm offset – see photo above. This will give a throw of 19mm

Then the work was clamped in the vice and the web milled to shape – left photo.



Cylinder

The cylinder was fabricated from several pieces of mild steel silver soldered/brazed together. I used a piece of 20mm dia. mild steel rod for the cylinder. The rod was faced both ends to get the correct length and a 13mm hole drilled through.

The top and bottom rings on the cylinder was discs parted off from a 30mm dia. mild steel rod. A hole was drilled through the discs and then opened up to 20mm – a tight fit over the cylinder.

The port block was made from a piece of hexagonal leaded free cutting steel, cut lengthways not far from the centre line. The piece was clamped in a toolmakers vice and I used a 20mm slot drill to cut the profile on the side facing the cylinder – right photo. The photo also show the cylinder with the top and bottom rings.

Part of the rings were then cut off so the rings fit closely against the portblock – right photo. This way there will just be tiny gaps between the various parts that make the cylinder. The tiny gaps will assure that the silver brazing material flows into the gaps and produces a strong joint. The leaded free cutting steel didn't give me any problems.

After silver soldering/brazing, the cylinder was pickled in citric acid solution for a few hours. The port block had moved slightly during the heating process so I mounted the cylinder on a 13mm mandrel and mounted the whole in my dividing head – right photo. This way I could skim the portface and make sure it would be parallel with the centreline of the cylinder bore. The toolmakers clamp is used together with a small angle plate to make sure the cylinder didn't move while machining the



portface.

The work was then transferred to the lathe and mounted in the 4-jaw independent chuck – left photo – and the 13mm hole I had drilled earlier was bored out to just under 16mm, and then reamed to 16mm with a reamer. The outer end was lightly

faced and marked, this will make this cylinder face at 90 deg. to the bore. This end will mount the bottom cylinder cover and trunk guide. The cylinder was then turned 180 deg. in the chuck and the other end faced. I had earlier made the top cylinder cover and this was used as a jig to drill 6 equally spaced 2.5mm holes in the cylinder, the holes were then tapped M3.

The next job was to mill the steam ports, the cylinder was mounted on a 16mm mandrel I had made for the slide valve engine I made earlier. The mandrel with cylinder was then mounted in my dividing head and the positions of the steam ports were marked out. I first used a centre drill to make a small mark where the in steam ports are, and then used a 1.5mm drill to drill holes to a depth of just over 4mm – right photo. This way the tiny



slot drill will have a starting hole, the in ports were milled to a depth of just over 4mm and 5mm wide. I used the same procedure for the exhaust port, except I used a 3mm drill and a larger slot drill.

After milling the exhaust port the diving head was rotated 90 deg. so I could drill a hole from the outside of the port block and into the exhaust port – left photo.



Next job on the cylinder is to drill the steam passages from each end of the cylinder and into the stem in ports. I mounted the cylinder in a tilting vice, and marked out the position of the bottom of the steam in ports on the side of the cylinder. I could then move the milling table and eyeball the correct tilt and position of the drill and set the depth stop so I wouldn't drill too far. First a small flat was milled and then a small centre drill used to make a mark before drilling the steam passage – right photo.

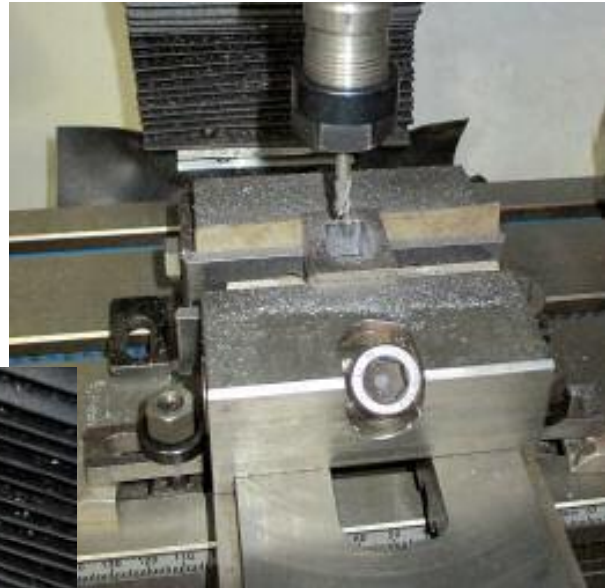
The 6 holes in the bottom end of the cylinder will be drilled when I have made the bottom cover. The 4 holes tapped M3 in the corners of the port block will be drilled when the steam chest has been made, using the steam



chest as a drill jig.

Steam Chest

I expect the engine to mainly be run on compressed air so the steam chest was made from a piece of 12mm thick mild steel. I drilled a couple of holes so I could put a Junior hacksaw blade through and then cut out a rectangular piece in the middle. Then the work was clamped in the milling vice and the inside walls milled to dimension – right photo.



I drilled and tapped a MF 10 x 1 hole at one end. At the other end a hole tapped M6. I threaded the end of a 10mm dia. brass rod to a loose fit in the MF 10 x 1 hole and centre drilled, then parted off to a suitable length. I did the same with a 6mm brass rod. The brass rods were then silver soldered/brazed to the steam chest. I could the drill a hole through the 10mm brass and use a long series centre drill to mark the 6mm brass rod – left photo. A long 2.5mm

drill was used to drill into the 6mm brass rod for a length of about 4 to 5mm. The hole in the 10mm brass rod was opened up and threaded with a fine pitch thread for the gland nut.

Next job was to mark the position of the four 3mm holes, one in each corner of the Steam Chest, and drill the four holes – right photo.



The Steam Chest can then be used to spot the corresponding holes in the Cylinder. The holes

in the Cylinder were drilled 2.5mm to a depth of 5 to 6mm and tapped M3. The Steam Chest Cover was made from a piece of Plexiglas.

Slide Valve

The Slide Valve was made from a piece of cast iron hack-sawed from an old disc brake. The work was first squared up in the milling machine and the small cavity marked out. I used a centre drill to drill a small hole in the centre and then an end mill that gave the correct width – right photo. The quill DRO made it easy to get the correct depth – nearly 2mm.



A smaller slot drill was used to mill the cavity to the correct dimensions. It should be nearly as long as the distance between the inside distance between the 1.6mm wide steam in ports, I went for 6.3mm.

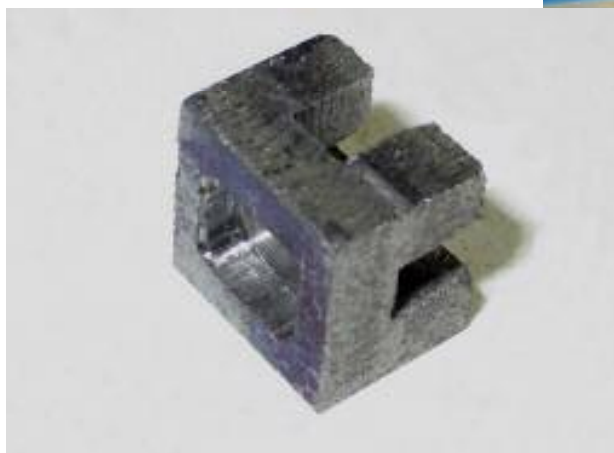


The work was turned 180 deg. so the cavity was facing down on the parallel and the milling machine spindle centred on the work. A 3mm slot drill was used to mill a 3mm slot to a depth of around 4.5mm. Then the work was rotated 90 deg. and a second slot milled – right photo.



One slot will allow a small nut, the other will allow the Valve Rod to pass. The underside will be rubbed flat on fine emery.

Left photo - the finished valve.



The Valve Rod with link was made the same way as I did for the first slide valve engine I made.

Piston

The piston – as the slide valve – was made from a disc brake that was about 8mm thick. A rectangular piece was hacksawed from the disc and the corners cut off, and a 3.3mm hole drilled in the centre. The hole was opened up to 4mm for a length of about 4mm, the rest was tapped M4.

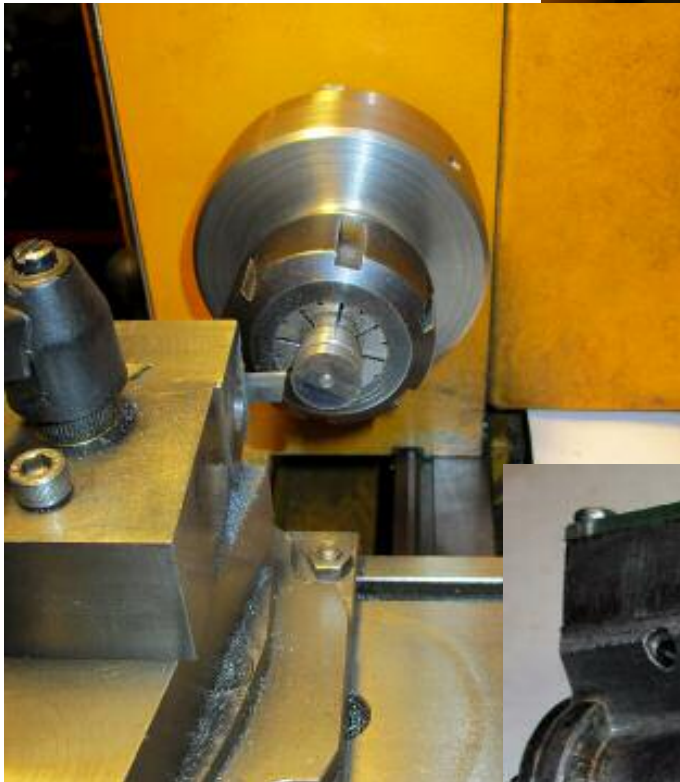
To be able to turn the piston I made a mandrel that could be held in the ER-32 chuck in my small lathe – right photo.



The piston could now be mounted on the mandrel and turned to a sliding fit in the cylinder.

I used a parting off tool to turn a packing groove in the piston – left photo.

The piston rod was made from a piece of 4mm dia. bright mild steel rod. I cut the M4 thread in the lathe to make sure the piston was square to the rod.



The Crosshead was turned from a Cast Iron rod and the Trunk Guide fabricated from some mild steel pieces from my scrap box. The photo to the right shows the Crosshead and the forked part of the Conrod.

This engine was a bit of experimenting and I found that I should have used free-cutting mild steel for the Cylinder itself as well as the portface (made of leaded free-cutting steel) gave a better surface finish than the cylinder and was much easier to machine. I had no problem silver soldering (brazing) the portblock made of leaded free-cutting mild steel to the other mild steel parts.

The Eccentric was made more or less the same way as for the previous slidevalve engine. The various parts were mounted and the Eccentric adjusted until the engine started running on compressed air.

Here is a photo of the engine running on compressed air.

