Vertical Steam Engine based on Stuart 10 Standard & Cylinder

By Thor Hansen

The Stuart 10V steam engine is a popular build among Model Engineers, buying the whole set was a bit expensive with the 25% VAT I would have to pay. However, you can buy spare parts for the Stuart engines and buying just the Standard and Cylinder were cheap enough that our Customs didn't bother with the VAT, so I have used the Stuart 10V Standard and Cylinder and made the rest from stock materials. I also used M3 screws/nuts instead of BA.
Many thanks to Graham Meek for his advice.

Materials

The Standard and Cylinder are Cast Iron, I used Aluminium for the Soleplate and Cast Iron, Brass and mild steel I found in my scrap box or in a skip nearby, some mild steel rods, the free-cutting stainless steel, M3 threaded rod, screws and nuts were purchased.

Standard

I started with the Standard, there was some casting flash and I used a grinding stone in my Dremel tool to remove that. I used an old round file to clean up the hole so I could just pass a scrap steel rod through. This way I could check if the top of the Standard was square to hole, and it almost was.

I used an old file on the top of the Standard to file the top flat and square to the hole.

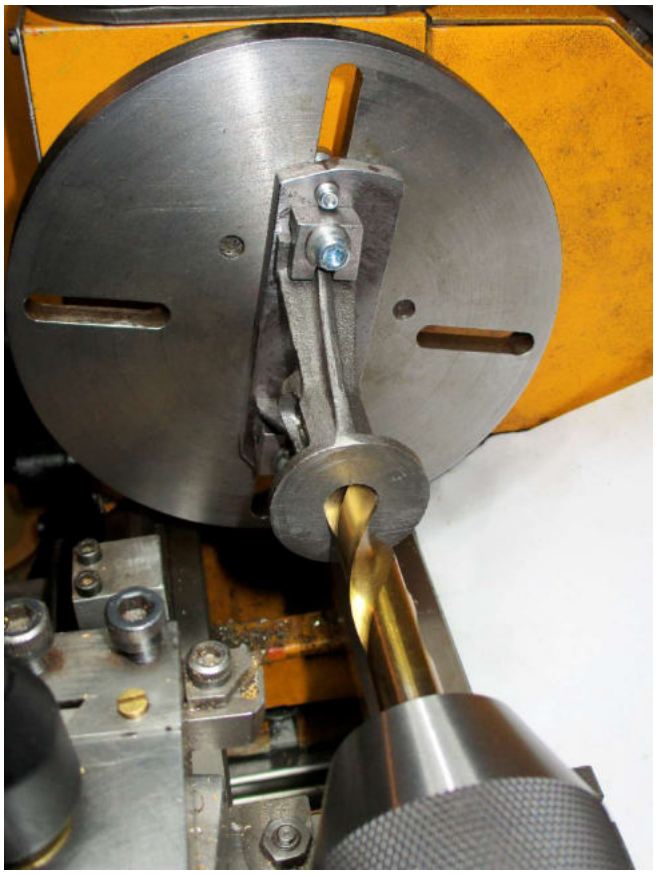
I could now mount the Standard upside down on my milling table using a suitable Allen bolt, a washer and T-nut, a piece of cardboard was placed between the milling table and the Standard.

With a carbide tipped tool it was possible to take light cuts to mill the bottom of the feet flat – right photo.

The next job was to make a small jig plate. I found a piece of flat mild steel and drilled and tapped a couple of holes in it so it could be mounted on the lathe faceplate with short screws from the rear (headstock) side of the faceplate. Each side was then faced to make the steel piece flat and the two sides parallel.

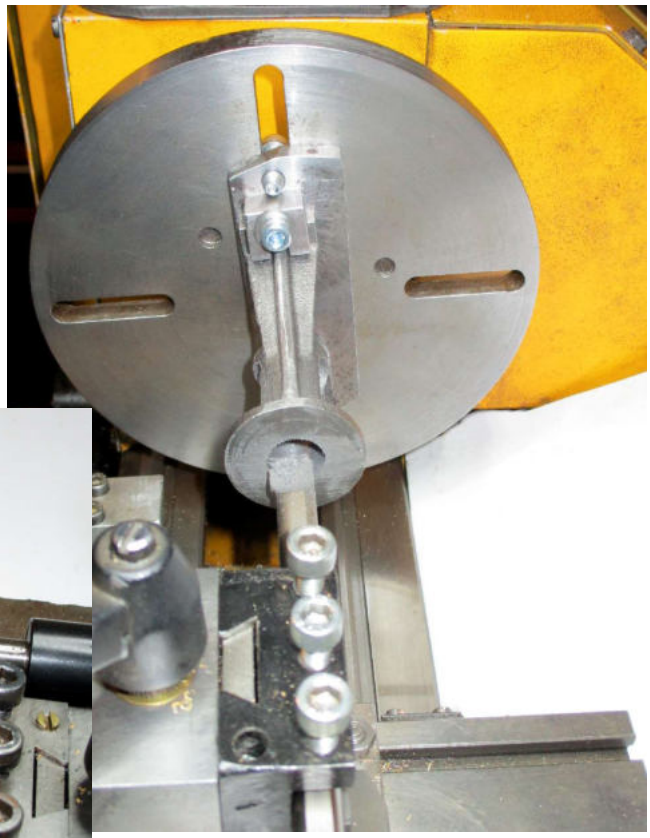
I also drilled and tapped a couple of holes so I could use some small clamps to clamp the feet of the Standard to the jig plate.

The Standard and jig was then moved to the lathe and mounted on the faceplate. The steel rod I had used to check if the hole was square to the top was now clamped in the tailstock drill chuck and the rod inserted into the hole in the Standard. This way I could press the Standard (and jig) against the Faceplate and insert the screws from the rear and tighten the Standard to the Faceplate with the hole running reasonably true (I was out between 0.1 and 0.2mm which was good enough for me).

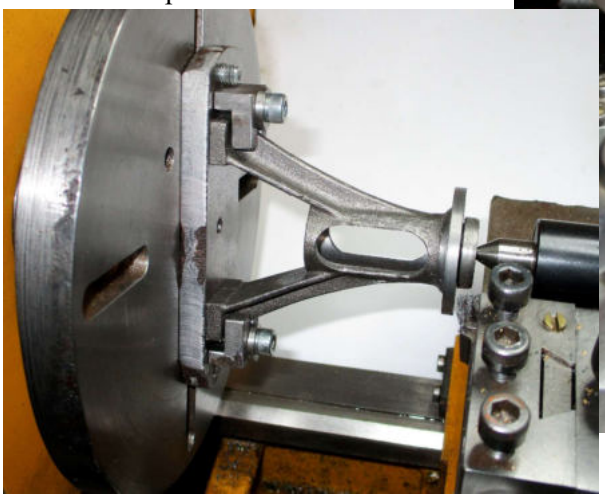


I first used an old drill to open up the hole in the Standard so my carbide tipped boring bar could be used – right photo.

Then the hole was bored to 16mm. I took several finishing cuts without any feed to take out the spring in the boring tool – right photo.



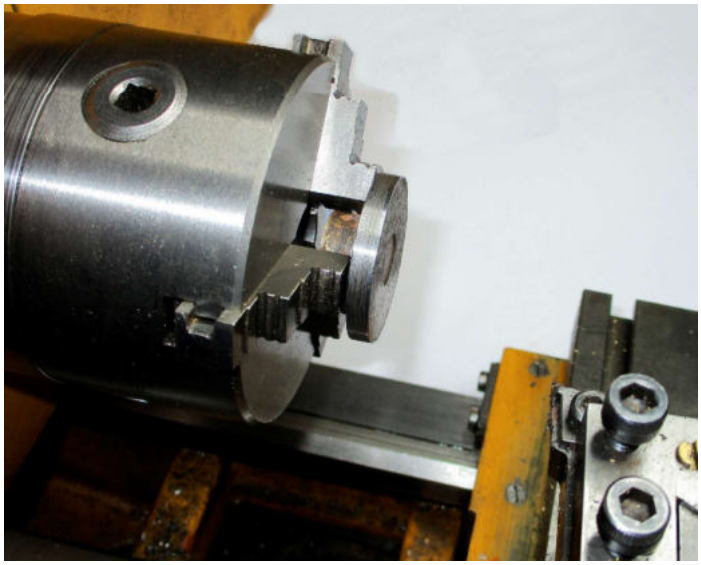
The top was then faced and I made a plug with a centre hole so I could support the end while turning the outside and left (under) side of the Standard – photo below.



The holes in the feet and in the top flange were drilled later after I had made the Soleplate and Bottom Cylinder Cover.

Bottom Cylinder Cover and Cylinder

I made the Bottom Cylinder Cover from a piece of brass (a bit over 16mm diameter) and some steel from my scrap box. I drilled a hole in the steel part and turned the brass for a length equal to the thickness of the steel part, so the brass would fit into the hole in the steel part. The two pieces were then silver soldered (brazed) together.

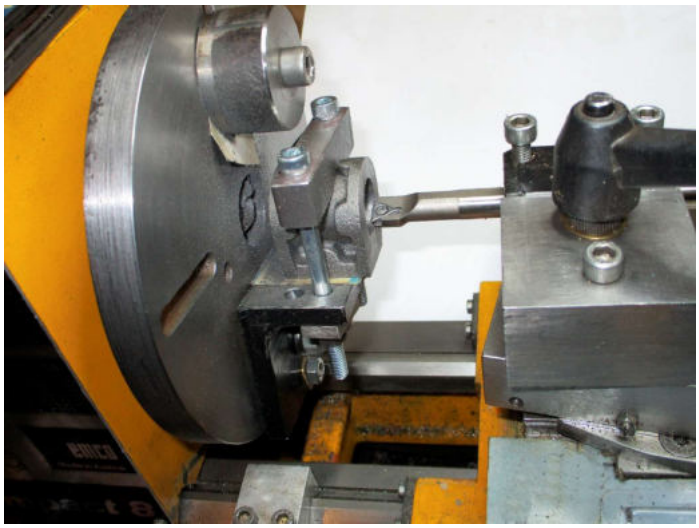


After pickling I could mount the cover in the 3-jaw and turn the outside to 35mm diameter – right photo. A small mark was made at the number 1 jaw. The spigot that enters the Cylinder was turned after I had bored the Cylinder to 19mm.

The Cylinder ends were square to the Portface so I just used a file to get the flanges flat so I could clamp the Cylinder to a small angle plate that I mounted on the lathe faceplate with the Portface facing outwards – right photo.

The Portface could then be faced, only a light cut was necessary to clean up the Portface. Since I was making the other parts from stock materials I didn't bother to machine to the dimensions given by Stuart.

I made a clamp to suit the curve of the Cylinder and could then mount the Cylinder on an angle plate with one Cylinder flange facing the lathe tool – right photo. I used a parallel behind to square up the Cylinder.
The end could then be faced (measure first how much you need to take off each flange to get the correct cylinder length). My Cylinder ended up a little over length so I get a bit more space above the piston.

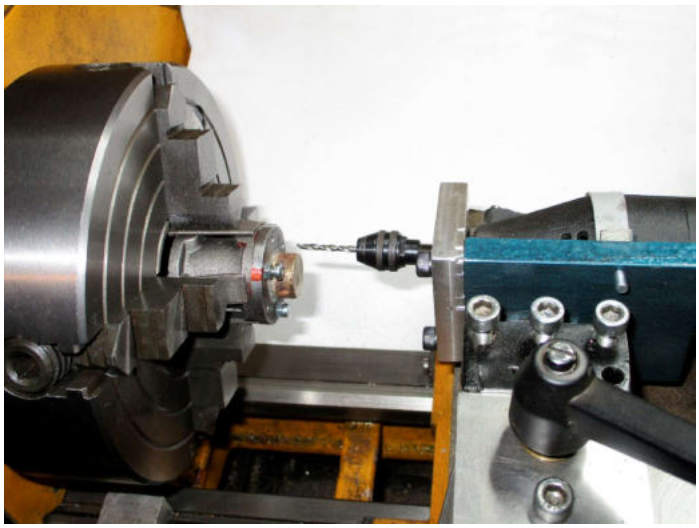


The Cylinder was then clamped in the 4-jaw and the other flange faced. A boring tool was then used to bore the Cylinder to 19mm – left photo.

The spigot on the Bottom Cylinder Cover was now turned to a good fit in the Cylinder bore. While still mounted in the lathe I used a scriber mounted in a tool holder to scribe a circle on a 28mm PCD – right photo.

The cover was then mounted in a 3-jaw chuck on the rotary table so I could mark out and drill six 3mm holes – left photo. Stuart uses five holes but it is so much easier when the holes are spaced 60 deg. apart.

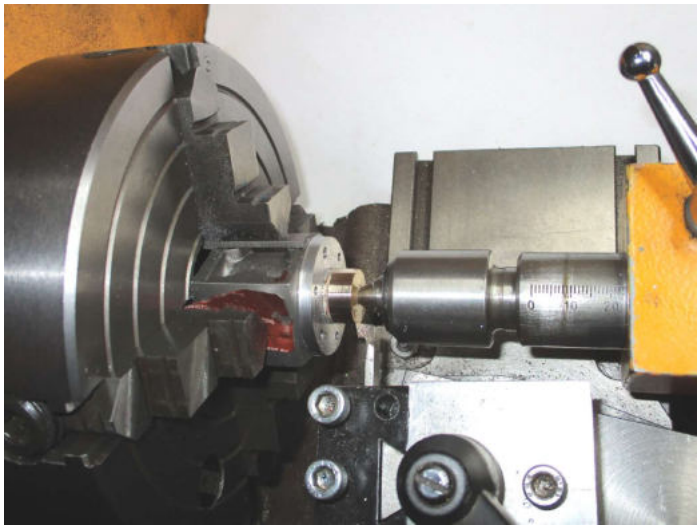
I could now use the Bottom Cylinder Cover as a drilling jig for the corresponding holes in the bottom Cylinder flange – right photo.



I used a 3mm drill in my Dremel tool (mounted at centre height) to mark the first hole in the Cylinder flange and a 2.5mm drill before tapping the hole M3. A M3 screw was then used to clamp the cover to the flange before the next hole was marked and drilled and tapped.

With 3 holes drilled and tapped I could clamp the cover and use a centre drill to drill a centre hole in the brass spigot that will enter the Standard.

The screws were then replaced with short studs so I could face the steel part and turn the brass spigot to a light push fit in the Standard – right photo.



The Bottom Cylinder Cover was also used to mark out the position of the six 3mm holes in the top flange of the Standard so Standard, cover and Cylinder can be clamped together.

The Cylinder was mounted in my tilting vice so I could drill the steam passages from the flanges and into the steam in ports – right photo.
I tried to mark out the position of the steam in ports on the side of the Cylinder so I could use the drill to check that my hole would line up and hit the steam in port in the Cylinder Port Face. I first used a small slot drill to mill a flat before drilling the holes.

The hole into the Exhaust port was also drilled and tapped.

This photo shows the finished Cylinder with the Steeam Chest.
I will replace the screws with pieces of threaded rod and nuts and I must make a gland nut.

Top Cylinder Cover

The Top Cylinder Cover was made from a 35mm dia. mild steel rod that I mounted (and centred) in the 4-jaw.

The end was faced and I turned the spigot to a nice fit in the Cylinder. Since I decided to use a nut at the end of the Piston Rod to lock the Piston in place I turned a cavity for the nut – right photo.

On the top side – closest to the chuck – I turned the cover a bit thicker before parting off using the rear toolpost.

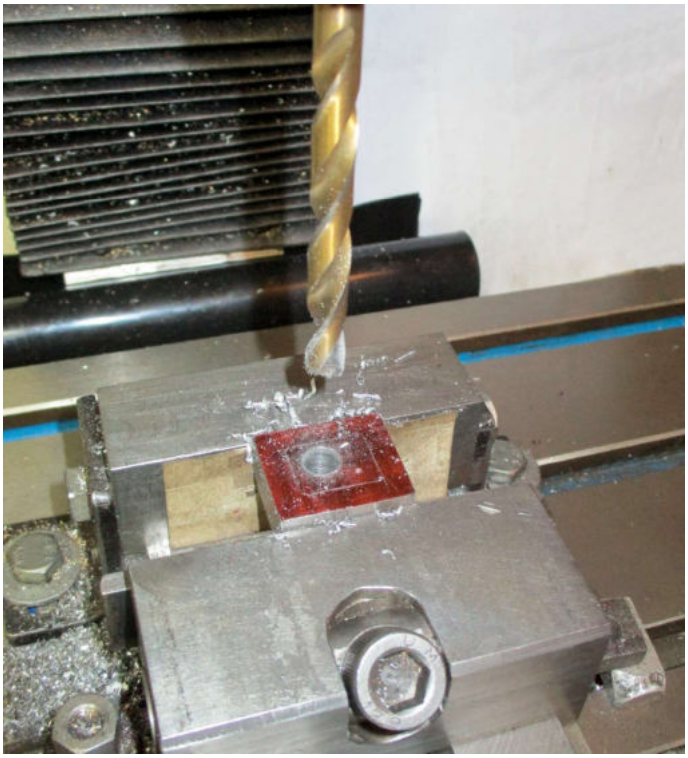
I marked out the PCD the same way as I did for the Bottom Cylinder Cover and drilled six 3mm holes 60 deg. apart.

The cover was then used to mark the position of the corresponding 2.5mm holes in the top Cylinder flange, the holes were then tapped M3.

Steam Chest

I made the Steam Chest from a piece of 13mm thick mild steel. The work was first milled square and to dimension, I then drilled a couple of holes so I could use a Junior hacksaw to cut out some of the metal – right photo.
Then the sides of the hole was milled to dimension.

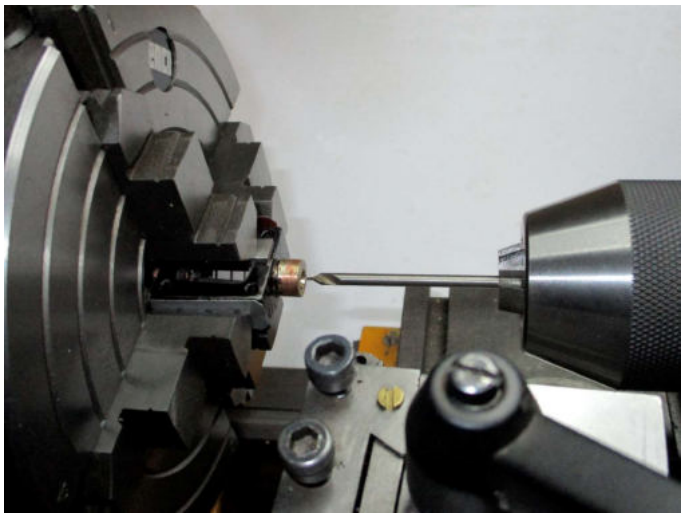
I marked out the position of the four 3mm holes that will clamp the Steam Chest to the Cylinder and drilled the holes.



In each short end I drilled and tapped holes for some brass rods that were silver soldered (brazed) in place – left photo.

The Steam Chest was mounted in the 4-jaw centred on the largest brass spigot that will become the Valve Rod Gland. I drilled and reamed a hole through the brass rod to fit the Valve Rod. The hole was opened up for about ¾ of the length of the brass rod so I could tap the hole for the gland nut.

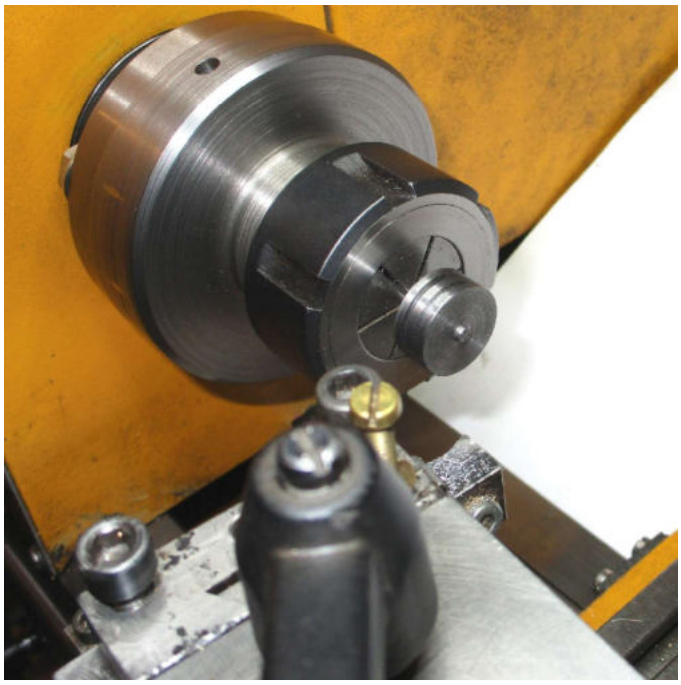
To start the 2.5mm hole in the brass at the other end I used a long reach Centre Drill – right photo. The end of the Valve Rod will enter into the 2.5mm hole so it is guided at both ends.



Piston

Since I don't intend to run the engine on steam, only compressed air I made the Piston from mild steel. The mild steel rod was chucked and the Piston turned slightly oversize and I used a parting off tool to cut two packing grooves. A 2.5mm hole was drilled, then a 3mm drill was used to enlarge the hole until well passed the middle of the Piston. The 2.5mm part was then tapped M3.

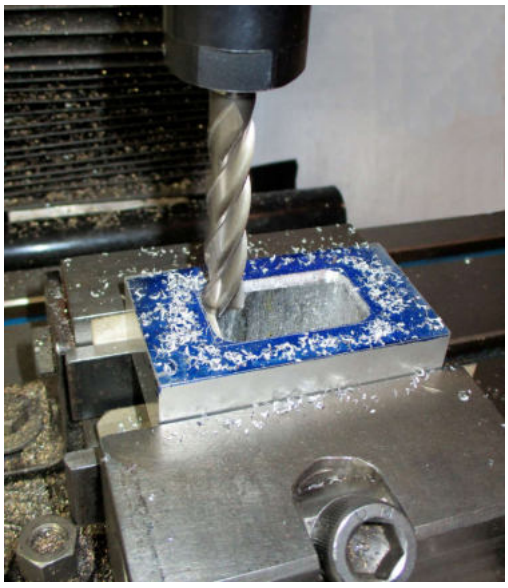
The Piston Rod was turned down to 3mm for a length about 3mm longer than the Piston thickness and the outer part threaded M3 for such a length that the threaded part protruded about 3mm above the Piston.



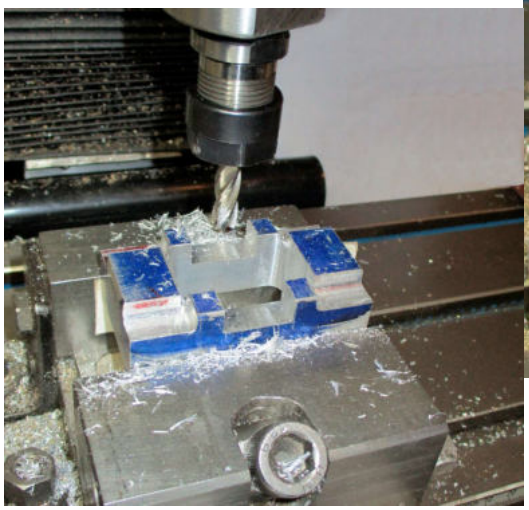
With the Piston mounted on the Piston Rod the rod was clamped in my ER 32 chuck and a few light finishing cuts taken so the Piston was a light push fit in the Cylinder – above right photo. I made the Piston Rod over length so I could adjust the length after I had made the Crosshead.

Soleplate

The Soleplate was made from a piece of 20mm thick marine grade aluminium. I marked out the position of the hole and drilled a couple of holes so I could use a Junior hacksaw to cut out the centre piece. A long end-mill was then used to mill the sides – right photo.



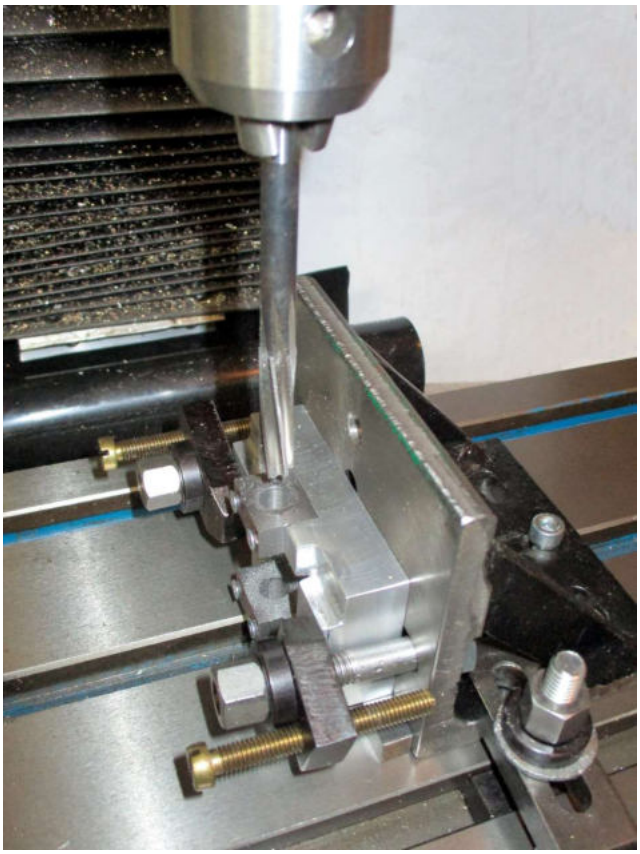
I then marked out the position of the cut outs for the Crankshaft bearings and the corners. I used an end-mill first and then a ball-nose end-mill for the corner cut outs – right photo.



An end-mill was used to mill the pockets for the Crankshaft bearings – left photo. The depth was so that the centre line of the Crankshaft ended up 1mm below the top of the Soleplate.

The Crankshaft bearings were made from Cast Iron (an old brake disc) and each bearing was made up from two parts.

The bearings were mounted on the Soleplate and the hole then mounted on an angle plate so the holes could be drilled – slightly undersize before reaming – right photo.
This way the bearings will line up and be parallel to the underside of the Soleplate.



Crankshaft

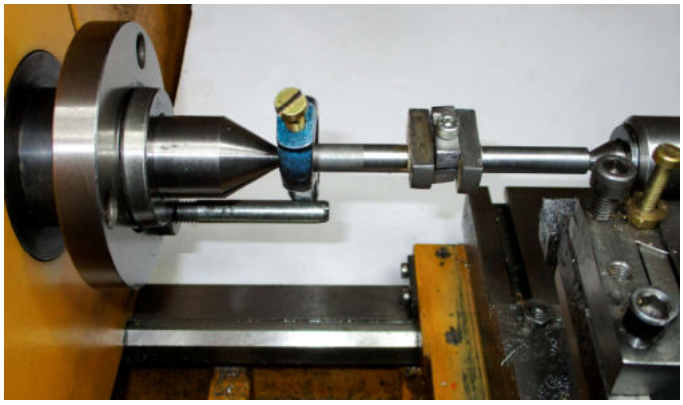
The crankshaft was fabricated from mild steel. I used a piece of 9mm round mild steel bar for the Crankshaft and Crankpin and two pieces of flat mild steel for the webs. A centre hole was drilled at each end of the Crankshaft.

I glued the two webs together and drilled the holes for the shaft and for the pin 9.5mm apart using the dials on the handwheels on the milling machine.

The parts were clamped in the vice and I drilled 2mm holes to pin the webs to the shaft and Crankpin – right photo.

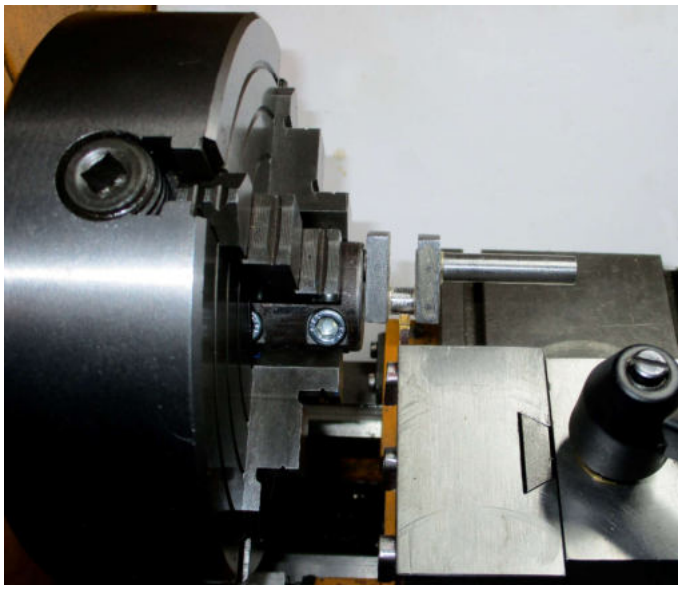
The parts were fluxed and then silver soldered (brazed) together.

I cut the Crankshaft between the webs and could not detect much movement due to tensions being released.



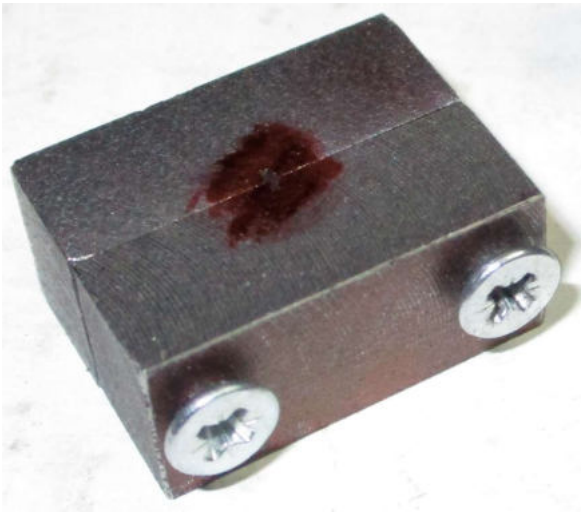
Then I made a spacer to put between the webs so I could mount the Crtankshaft between centres in my lathe – right photo.

The Crankshaft could now be turned down to 8mm diameter and the outside of the webs turned.



I also made a jig with a 8mm hole offset 9.5mm so I could turn the Crankpin down to 8mm diameter using a carbide tipped parting-off tool.

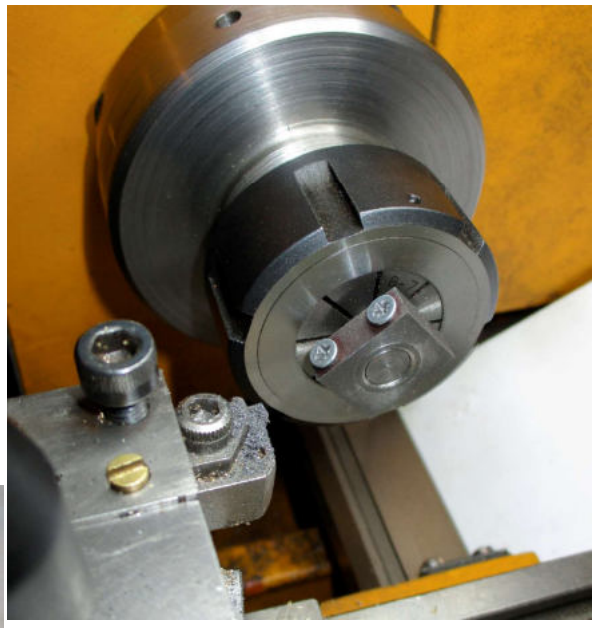
Conrod



I made the Conrod from several pieces of mild steel. I started with the split big-end bearing which was made from Cast Iron taken from an old disc brake.

I used a hacksaw to cut out the two pieces and then milled them to dimensions. Then two 3mm holes were drilled through one piece, then a 2.5mm drill through the other piece. The 2.5mm holes were tapped M3 so the pieces could be clamped together – right photo.

A 7.9mm hole was drilled through the bearing and reamed 8mm.

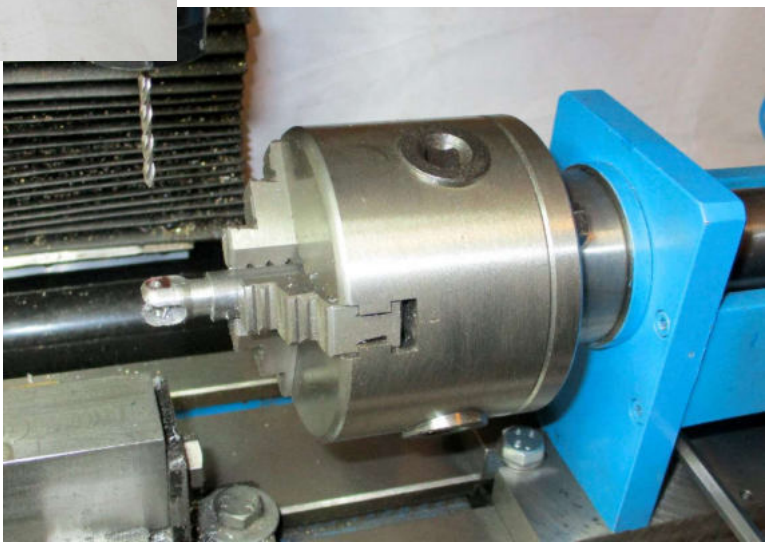


The Bigend bearing was then mounted on a mandrel that was just over 8mm diameter at the outer end – right photo.

This way I could turn each side of the bearing to get it square to the 8mm hole. Later the tapped holes were opened to 3mm.

A mild steel piece the same size as the Cast Iron bearing was then made and the bearings used to spot the two 2.5mm holes to be tapped M3

The bottom photo shows the bearing on the Crankshaft.



The other end of the Conrod was made from a piece of mild steel rod.

First I mounted the rod in the lathe chuck and turned the shape before moving the chuck 8and work) to my indexing head so I could mill and drill – right photo.

The two parts was then joined using a mild steel rod threaded at each end.

Eccentric

The next job was to make the Eccentric and Eccentric Strap.

The Eccentric was made from a piece of 22mm dia. mild steel rod that I faced. Next I used a parting off tool to turn the groove for the strap.

The work was then clamped in the milling machine using an ER 32 collet chuck – right photo. After finding the centre the table was moved 2.5mm before using a centre drill to make a small dimple for the drill to start in. A 7.8mm drill was used to drill through and the hole reamed to 8mm.

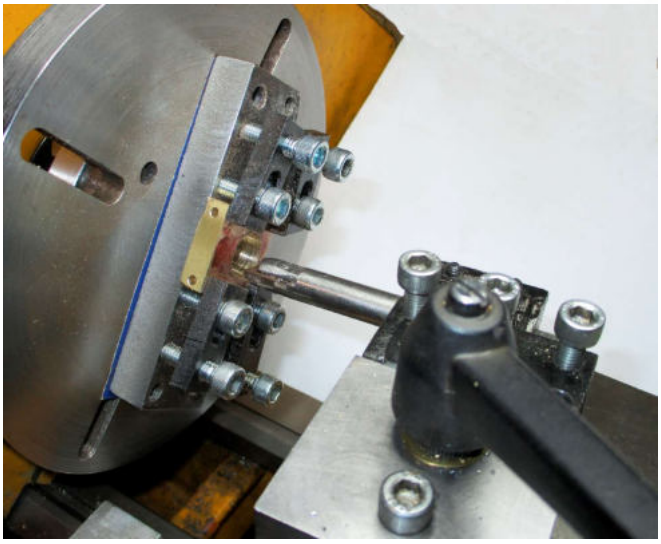
The work was then transferred back to the lathe and parted off.

The Eccentric Strap was made from two pieces of brass. The two pieces were glued together and two 2.5mm holes were drilled. The 2.5mm holes were opened up to 3mm in the short brass piece, the holes in the larger piece were tapped M3 so the two pieces could be clamped together.

The outline of the strap was marked as well as the centre – right photo.

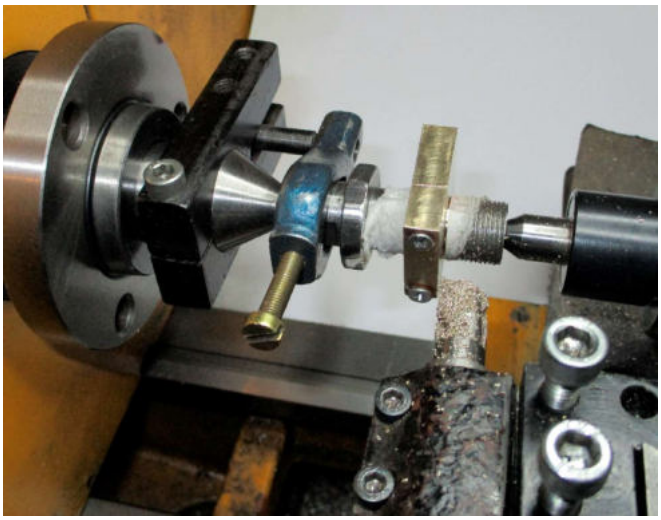
The work was then clamped to a small jig plate that was clamped to the lathe faceplate.

I could then centre the Eccentric Strap and drill and bore the hole to dimension – right photo.



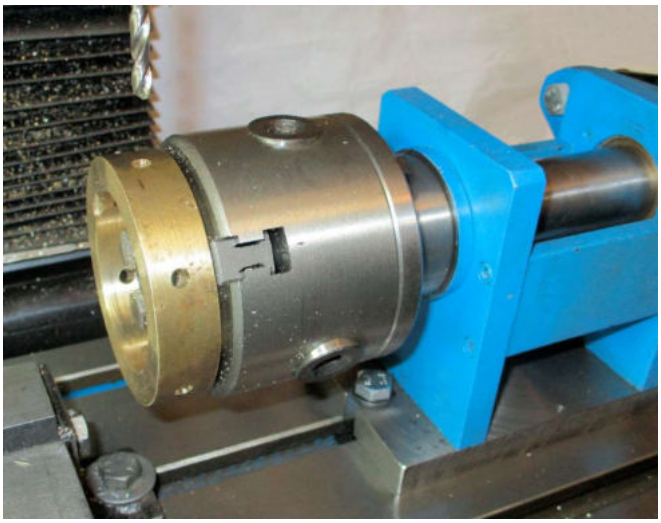
I happened to have a mandrel that I could use to clamp the Eccentric Strap so I could finish turn the strap to correct width – right photo.

I also turned one end and drilled and tapped a hole, photo below.



Flywheel

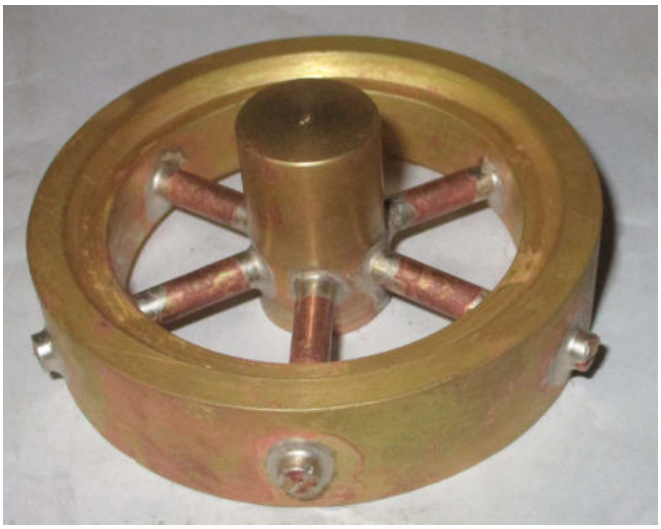
A friend of mine was given some old brass parts and among them were a short piece of thick-walled tube nearly 3 inches in diameter that I could use as the rim part of a built up flywheel. I mounted it in my indexer and drilled six 5mm holes 60 deg. apart, right photo.



I did the same with a piece of 18mm brass rod, except I used a 4.3mm drill and drilled to a depth of about 5 to 6mm. The holes were then tapped M5. This was used as the hub.

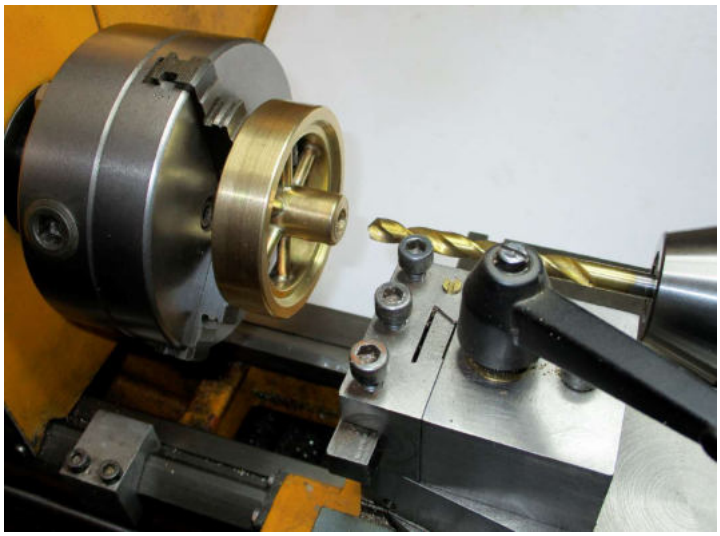
I also used six pieces of 5mm brass rod that I cut M5 threads on one end to make spokes – right photo.

The parts were then fluxed and silver soldered (brazed) together. After the wheel had cooled I pickled in a Citric Acid solution – right photo.



The flywheel was then clamped in the 3-jaw chuck on the lathe and the end faced. A centre drill was used to mark the centre of the hub before drilling through with a 7.8mm drill. The hole was then reamed to 8mm – right photo.

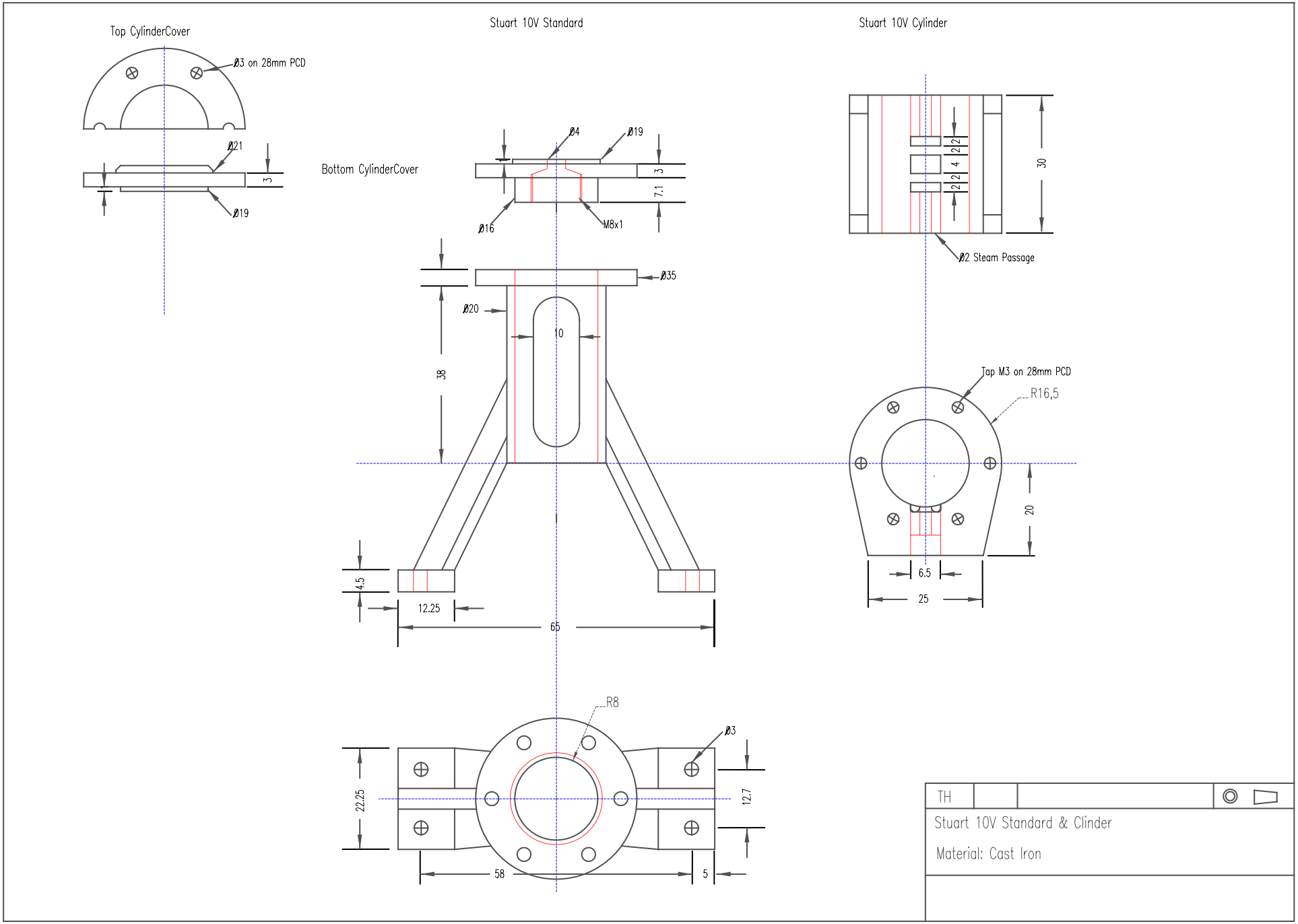
I also finish turned the outside of the protruding part of the hub so it would run concentric with the Crankshaft.



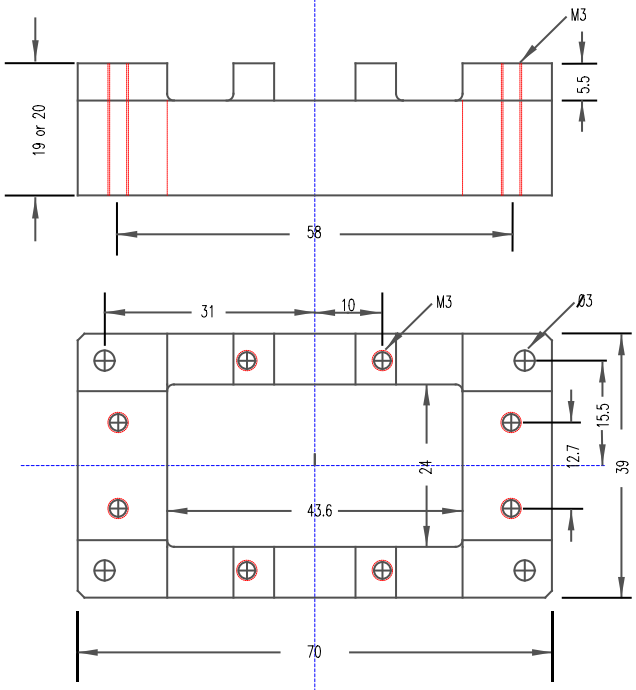
I turned the work around and faced the other end of the hub and turned the protruding part to run true. The work was then mounted on a mandrel and the outside and sides turned to run true.

I then used a small wire brush in my Dremel tool to clean up – right photo.

The (almost) finished engine was given a coat of green paint (RAL 6005) on the Soleplate and Standard, and the Cylinder a coat of black paint while I am trying to find some thin brass sheet.


Top CylinderCover
Ø3 on 28mm PCD
Ø21
3
Ø19
Stuart 10V Standard
Bottom CylinderCover
Ø4
Ø19
3
7.1
Ø16
M8x1
Ø35
Ø20
10
38
4.5
12.25
65
R8
Ø3
22.25
12.7
58
5
Stuart 10V Cylinder
2
2
4
2
2
30
Ø2 Steam Passage
Tap M3 on 28mm PCD
R16,5
20
6.5
25
TH
Stuart 10V Standard & Clinder
Material: Cast Iron

Stuart 10V Soleplate



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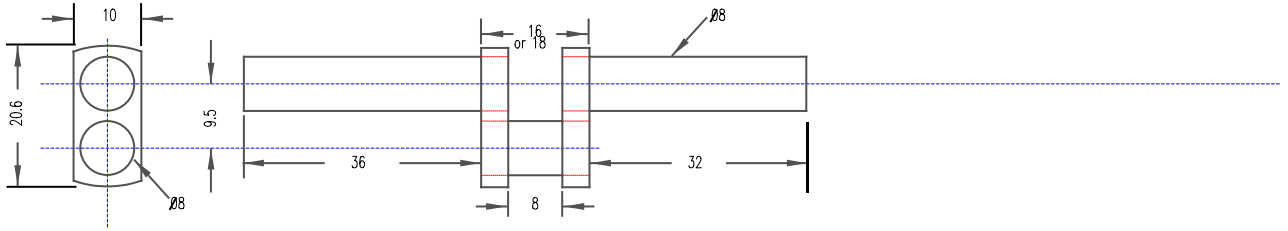
Stuart 10V Soleplate

Material: Aluminium

Stuart 10V Crankshaft

Stuart 10V



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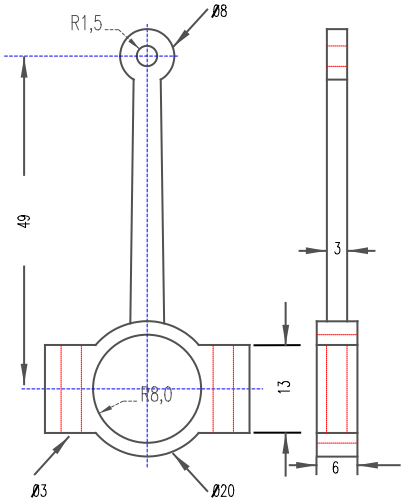
Stuart 10V Eccentric Strap



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Stuart 10V Crnkshaft, Eccentric ...

Material: Mild Steel, Brass etc