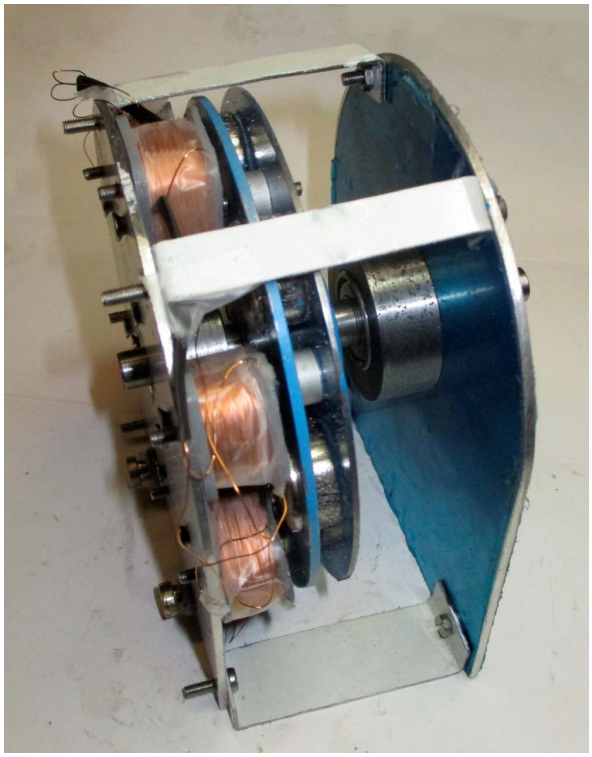
Axial flux generator



After making several small model steam engines – running mostly on compressed air – I decided to give my steam engines something to run. A small generator would be ideal, but most of the small generators I have seen need high RPM, usually over 1000 RPM, I wanted a generator that could generate useful voltage at a few hundred RPMs. I decided to try to make one of the permanent magnet axial flux generators roughly based on those used for small wind turbines. Such generators with no iron core doesn't have the "cogging" effect so even my small steam engine models might be able to run the generator. I adapted the design to what I had available. I had been given some cylindrical Neodymium magnets – 20mm dia. and about 15mm long, I also had a simple filament 3D printer I used to make something to wind the insulated copper wire around.

Since this was my first attempt at building a generator I expected to have to do a bit of trial and error to see what worked. Most of the materials came from my scrap-box but I bought a couple of ball bearings and some insulated copper wire and some 2mm Aluminium sheet.

Holding the magnets

I decided to use a piece of 1mm thick sheet steel (mild steel) together with a piece of the 2mm thick Aluminium alloy sheet to hold the magnets in place. The Neodymium magnets are very strong and once in contact with the steel I could only slide them sideways.

I started by cutting a suitable square from the steel sheet and cutting off the corners to get an octagon shape.

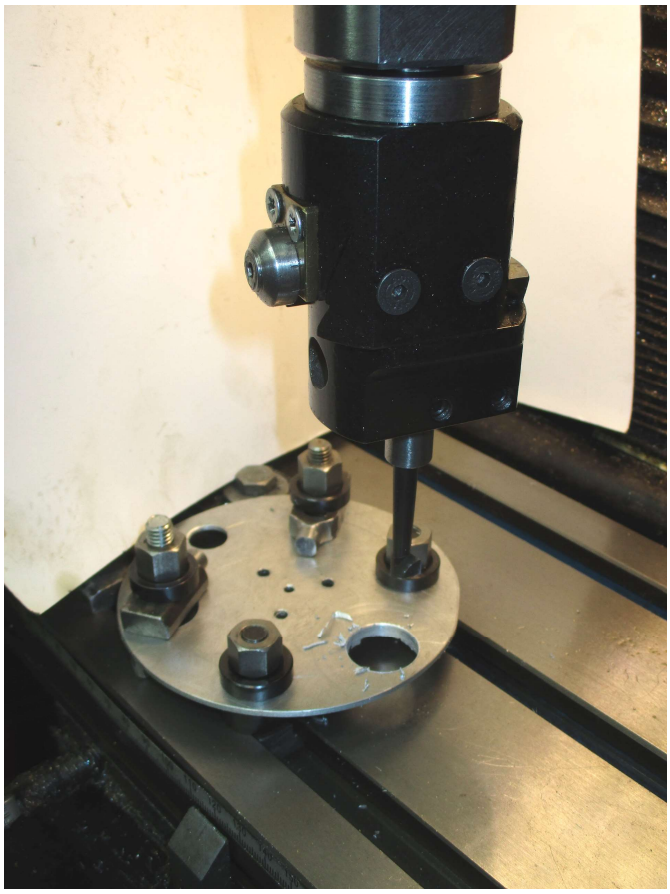
When I made endplates for my simple pot-boiler, I made a jig for holding and spinning the copper end plates, I used the same jig to turn the octagon circular – right photo.

I used the same set-up for the Aluminium alloy sheet.

Six 2.5mm holes were drilled and tapped M3 (on the same PCD as used for the 3mm holes drilled in the Aluminium).

To keep the magnets in place I used a compass to mark the PCD and divide the PCD into six parts so I could centre punch and drill six holes. My drills go up to 13mm so I used my home made boring head to enlarge the holes to a sliding fit for the magnets – right photo.

The photo also shows a hole in the centre – used for centring the sheet metal, and three holes used to drive the unfinished piece when using the spinning jig.



I also used pieces of 10mm dia. Aluminium rod to create spacers so the Aluminium sheet was spaced away from the sheet steel. A 3mm hole was drilled through each spacer.

When I marked out the PCD for the holes for the magnets I also marked out holes for the spacers (between the larger holes for the magnets) and then drilled through 3mm.

The hole in the centre was opened up.

A mild steel hub was then turned, the right photo shows the two plates and the hub. The steel plate is attached to the hub with three countersunk M3 screws.

The plates was given a coat of paint and the magnets slid onto the steel plate and adjusted so the aluminium plate with the larger holes fitted and the spacers mounted as shown in the right photo.

Stator

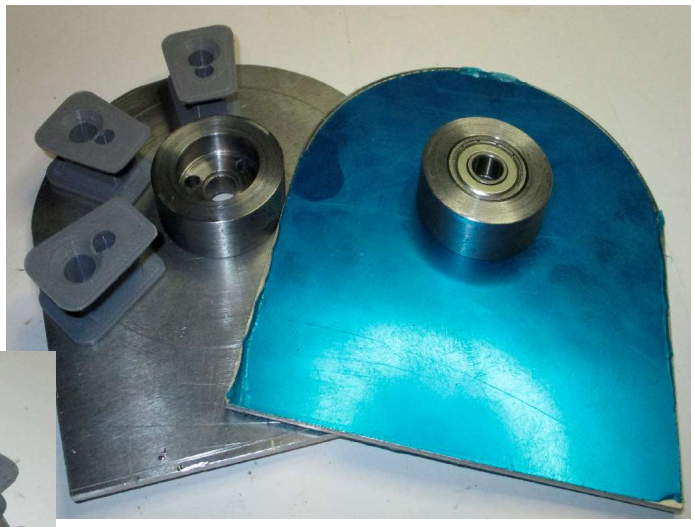
With the rotor finished the next job was the stator, I made that from two pieces of 2mm Aluminium sheet.

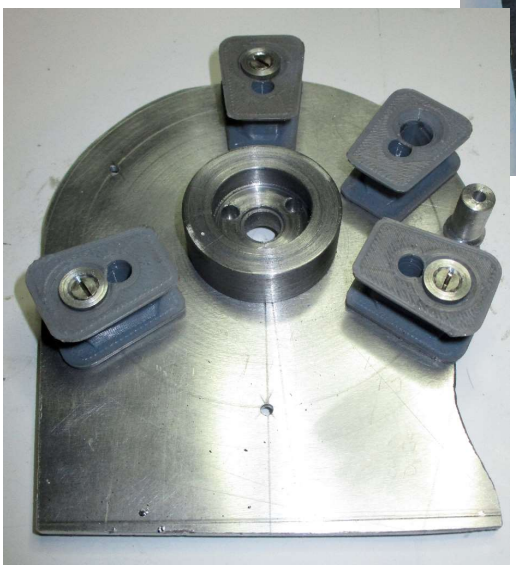
I used my home-made rotary table to mill the arc at the top – right photo.

I also marked out the PCD for the 3D printed coil holders and a centre hole.

Two bearing blocks were turned from mild steel rod and the hole for the ball bearings bored to a push fit.

The right photo shows the two stator plates and three of the 3D printed coil holders.





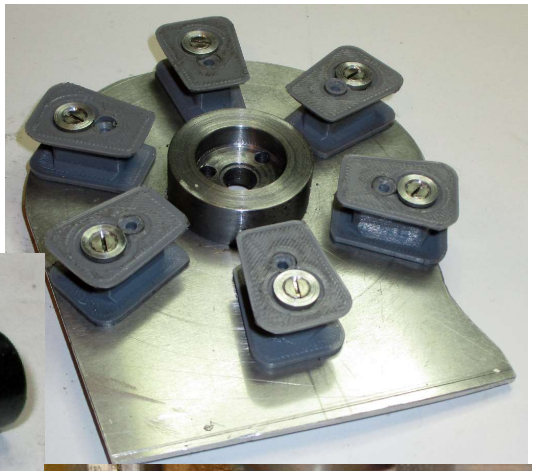
The six 3D printed coil holders were modelled in FreeCAD and printed on a simple 3D printer. I made the coil-holders with one larger hole and one smaller. The larger hole was intended for a Aluminium or mild steel bush since I intended to find out if a steel core gave to much "cogging", it did so I ended up turning the bushes from Aluminium rod.

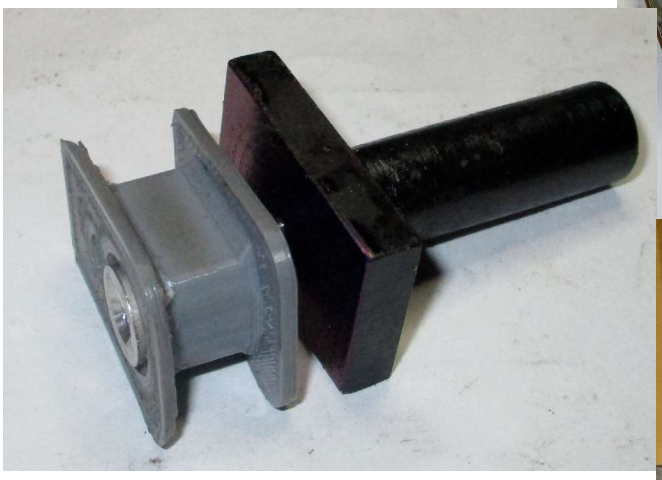
The left photo shows three of the coil-holders and a fourth with one of the bushes.

The coil-holders made it much easier to wind the coils and keep the windings in place.

Winding the coils

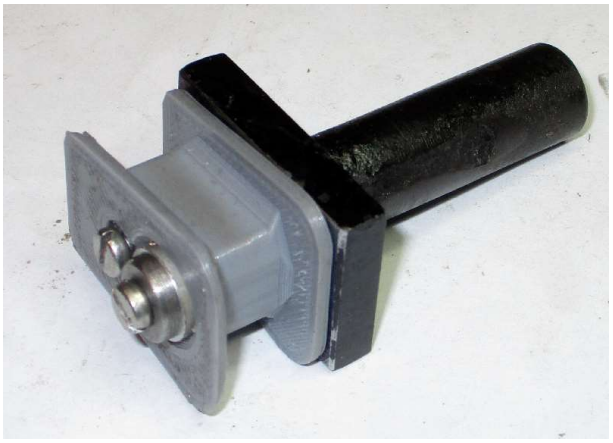
I first used some 0.8mm insulated copper wire I had been given some time ago and tried to wind a coil, it barely moved the needle on my multimeter so I bought some 0.25mm insulated copper wire and used that. When tested one coil gave around 1V on my multimeter.





I decided to use my lathe when winding the coils so I needed something to hold my 3D printed coil-holders so I made a jig – see photo above.

I wanted to be able to test if coil holders with mild steel cores gave higher voltage so the screw holes in the coil holders were oversize. In the jig for winding the coils I drilled two 2.5mm holes – right photo – and tapped M3 so I could clamp the 3D printed coil-holders to the jig – see photo below.



Then I could clamp the jig in the chuck on the lathe for winding the copper wire on the coil holder – right photo. This worked fairly well using the lathes slowest speed, I then used some adhesive tape to hold the copper wire in place.