University of Texas at Arlington SPS Research Interim Report

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Research

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Researched Databases:

We first began by looking for studies done concerning our type of coil. Among the databases of physics journals searched are arXiv, Physical Review Letters, and JSTOR. These databases did not contain any information on our specific coil type. It turns out that interest in this coil type is purely hobbyist. Because of this, most of our information came from amateur accounts. Information such as suitable gauge, number of spokes, voltage ranges, and core types extracted from the hobbyist community was then sent on to the design team.

Simulation

Blake Watson, Ryan Hart, Esau Hervert

Software:

In the past month and a half we have searched for a suitable program to map the magnetic fields of a given wire. We have researched programs such as Mathematica, SIM ION, and its CPO variants. For our purposes, we have decided to use Mathematica for constructing the geometry of the coil and as a rudimentary way of mapping the magnetic field. The drawback to using this software is that we are unfamiliar with it and will take time to get a hold of and to learn.

Geometry:

We are modeling the geometry of the coil as a hypotrochoid in the *xy*-plane (Fig. 1), given algebraically as:

$$\begin{bmatrix} x(t) \\ y(t) \end{bmatrix} = \begin{bmatrix} (R - r)\cos(t) + d\cos\left(\frac{t\,(R - r)}{r}\right) \\ (R - r)\sin(t) + d\sin\left(\frac{t\,(R - r)}{r}\right) \end{bmatrix}$$

Equation 1. Parametric equations for a hypotrochoid

Where R, r, and d are constants. In 3 dimensions the projection of the winding on the other axes is less clearly defined (Fig.2). Though we are still working to generalize this equation, we know the z parameter will take the form: $z(t) = \sin(kt + \phi)$ where k and ϕ are constants.

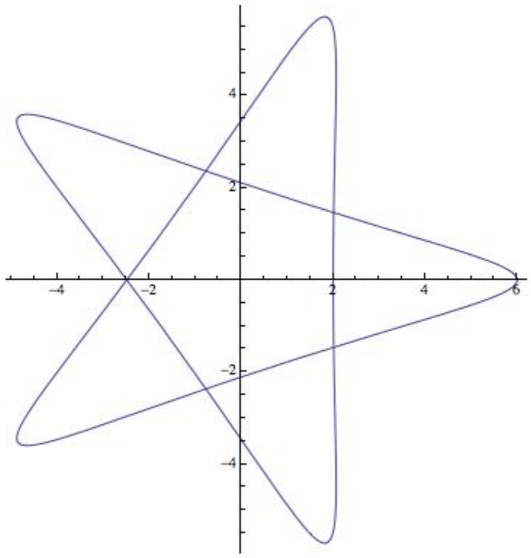

Figure 1 – An example of a hypotrochoid in the *xy*-plane produced using Mathematica.

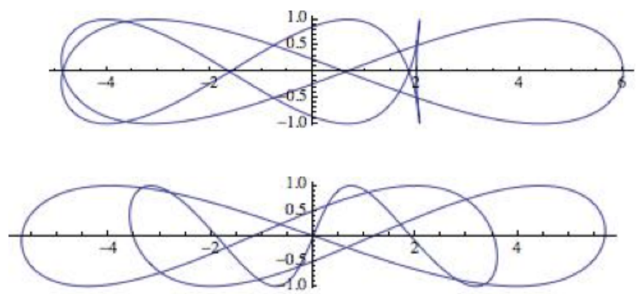

Figure 1 – The projection of the 5-spoked 3 dimensional winding pattern onto the *xz*- and *yz*-planes.

The geometry presented above will allow simple determination of the magnetic field of our coil. The actual coil is different from our model in two ways: First, the coil is composed of several layers of windings each carrying a given amount of current. We simplify this problem by saying that the current in our model will be given by $I = nI_0$ where n is the number of times the wire is wound about the torus scaffold, and I_0 is the current through the wire. Second, the final coil will have two windings both carrying possibly different current. We can model this new winding by simply copying and rotating the original coil. By the principle of superposition as it pertains to electromagnetic fields the total magnetic field will simply be the sum on the two fields produced by the two paths of wire.

Design

Frank Allen

Using the data provided by the research team, we created a prototype coil using 25 AWG gauge magnet wire wound around a 10' diameter polystyrene torus. Figure 3 contains a picture of this coil.

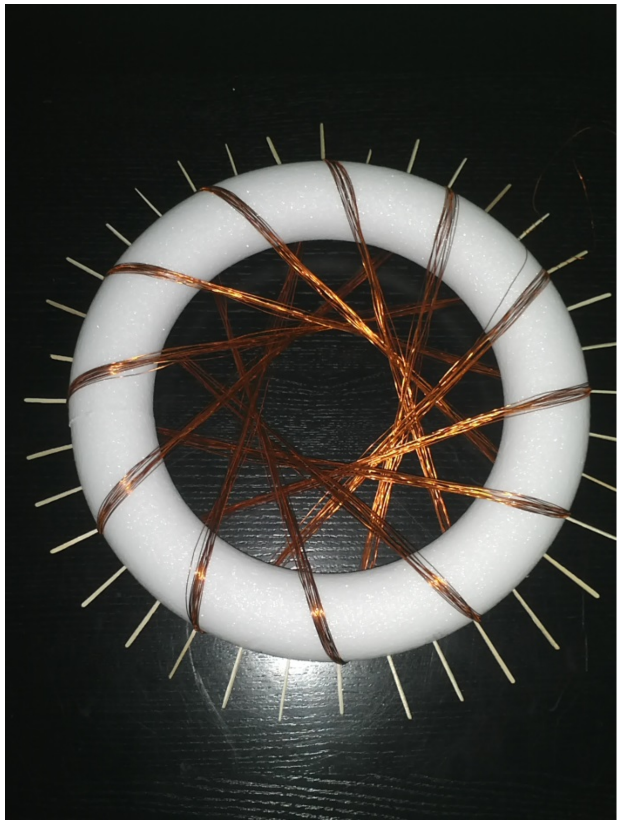

Figure 3. A prototype coil containing twelve point wound twelve times.

The winding pattern itself contains twelve points separated by 30 degrees. The wind was repeated a total of 12 times and its resistance was calculated to be approximately 4.8Ω, and physically measured at 5.8Ω. Testing of the magnetic field of this coil is scheduled to begin within the next week.