

The Design, Construction, Modeling, and Operation of a Two Phase Spherical Electric Machine

LT Clinton T. Lawler, USN

Prof. Markus Zahn	Dr. David V. Burke
Thesis Supervisor	Thesis Reader

Rotating magnetic fields are used to turn everything from screwdrivers and coffee grinders to locomotive engines and ship propellers. These machines function on principles that are well understood and well documented. However, the design and construction of these machines is a constantly evolving field. Engineers and scientist are continually seeking ways to increase the power density, efficiency, and utility of these machines. While this thesis does not discuss the design of industrial motors or generators, it does probe the basic physics and engineering of these machines. In fact, the machine that has been designed and built as part of this thesis was conceived in order to correct the deficiencies of and replace the conventional motor armatures that have been used to excite ferrofluids in the previous experiments.

This thesis describes methods for creating uniform fields in solenoidal air-cored magnets and provides a design for a machine capable of generating 25 milli-Tesla rotating uniform magnetic fields. The design uses two concentric spherical coils, sometimes called *Fluxballs*, to create a 15 cm test chamber with highly controllable, uniform magnetic fields. The design has been constructed, and its geometric, electrical, and magnetic properties have been verified. Experiments have been conducted using the machine to look at the governing equations of ferrofluids and to measure attenuation of magnetic fields passing through conducting materials.