# A STUDY INTO THE FUNDAMENTALS AND ENHANCEMENTS OF SOLENOID BASED ACCELERATORS

by

William Poole

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Advisory Committee:

David Kotecki, Associate Professor

Nuri Emanetoglu, Associate Professor

Donald Hummels, Professor

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ABSTRACT

Initial research into coilgun projects determined that they have a common issue of low efficiency and design complexity. This research aims to cover the topics of solenoid applications, magnetic fields, wires properties, and more for specific task optimization. There are many factors that come into the design and operation of solenoids which make them complicated to utilize effectively. These points will be combined for the overall system aspects dependent on application. These applications can be steady state for solenoid valves, high force for coil guns, and response time for chemistry applications. Coilguns have been studied for their unique ability to accelerate an object without adding weight or manipulating their design to allow for launches by alternative means. This advantage is purposely exploited for either a satellite launcher or another projectile accelerator. To get this data and review its interpretation my Honor’s Thesis committee shall be utilized. To prove some of this data, the ECE capstone project coilgun will use these concepts to enhance its optimization.

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List of Definitions

|  |  |
| --- | --- |
| Current |  |
| Efficiency |  |
|  |  |
|  |  |
|  |  |
|  |  |

# Introduction

A coil gun is a complex device that has many aspects which can be varied for specific applications. The following is a theoretical and experimental insight into many of these variables and how to utilize them in understanding these devices. These variables can be combined into the following groups, Electromagnetic Principle, Technologies, System design, and Losses. These groups explain the function and method of any coil gun operation. With these aspects of a coil gun theory the application can be optimized.

# History

This technology is quite old starting in the early 1900’s with a patent by a Norwegian scientist in 1904 being one of the earliest documents [3]. Past this earlier variant it has fallen into 2 main categories projectile or vehicle acceleration. Projectile acceleration is the gun designed to throw a projectile with the intent to have it destroy something, usually military. An example of this is the Darpa project to enhance mortar systems by replacing propellant weight and increasing distance [1]. Whereas the alternative is something that accelerates a container to deploy something at a distance. One of the vehicle launchers was the NASA super-cooled coil gun or quench gun project for launching liquid oxygen off of the moon for use in spaceships [2]. Allowing this technology to be used for new purposes whenever an object needs to be thrown.

# Research

## Electromagnetics

### Equations

ω=Angular frequency [Radians]

L=Inductance [Henrys]

L=μAN2/L [H/m \* m^2 / m]

N=#of turns [unitless]

ZL=jωL

TL=L/R

### Circuits

#### Supplies

#### Control

#### Solenoid/Power

# Bibliography

[1] B. N. Turman and R. J. Kaye, “EM MORTAR TECHNOLOGY DEVELOPMENT FOR INDIRECT FIRE.” Sandia National Laboratories, Albuquerque, Nov. 1, 2006

[2] N. Nottke and C. Bilby, “A Superconducting Quenchgun for Delivering Lunar Derived Oxygen to Lunar Orbit.” National Aeronautics and Space Administration, Austin, Apr. 1990

[3] S. Chaithanya and V. P. Kumar, “A Review on Technological Advancement in Electromagnetic Coil Gun System.” International Journal of Engineering Research & TEchnology, Ujire, 2018

# Appendices

# Author’s Biography