Railgun

Author: Mary Elizabeth Brittain

Professor: Dr. John Stewart

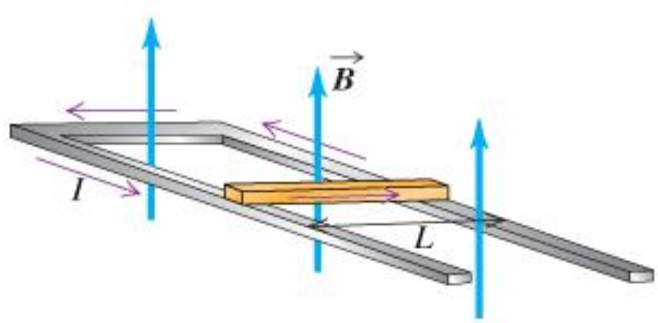
Lab: H-2

TA: Justin Mitchell

Date: April 26, 2011

History:

Railguns, also known as Electromagnetic Accelerators, have been around since before World War I. In 1919, Andre Louis Octave Fauchon-Villeplee, a citizen of Paris, France, filed a patent on "Electric Apparatus For Propelling Projectiles". According to this patent Villeplee laid out his invention of the first Electric Apparatus For Propelling Projectiles or railgun (Villeplee, 1919). During World War II there was a spike in interest over the railgun including that of Dr. Joachim Hänsler of Germany's Ordnance Office. Although Dr. Hänsler did not develop a working railgun suited for the military before the war ended, he did have numerous calculations that helped further the research in magnetic railguns (McNab, 1999). In January 2008 the U.S. Navy "successfully conducted a record-setting firing of an electromagnetic railgun" (Babb). The railgun has the capability to fire 200 nautical miles with muzzle velocity of mach seven with impact at mach five. Railguns can be dangerous depending on levels of current being run through the projectile. The rails and the projectile itself may get to very high temperatures.



The Physics:

The physics behind the railgun is merely a Lorentz Force (using the cross-product) on a projectile down a set of parallel rails in which a current is supplied. The figure above demonstrates the basic layout of the project. In the construction; the rails are made of Tungsten welding electrodes (TIG electrodes), the power source is a DeWALT © power drill battery, the projectile is another smaller piece of Tungsten that has been pushed through a pen cap, and although the current moving through the wires create a magnetic field, this construction has Neodymium bar magnets (poles on the long flat sides) to produce a large nearly uniform field. For the track, a piece of wood, six inches long, with three grooves have been carved, one centered down the length, and two thin on opposite sides of the center groove. The thin outside grooves are for the rails and the center is for the projectile. A switch maybe used but is not a necessity. Each material is chosen for a specific reason, for example Tungsten has a considerably high melting point and for this reason the rails and the projectile has been constructed of welding electrodes made of Tungsten. The projectile is only mounted on the pen cap for stability; this prevents the projectile from sliding sideways on the rails or flying off. The rails are mounted using tight fitted grooves or a mild adhesive. The rails should be about seven inches long to have room to be connected to the power supply. To create a close approximation for a uniform magnetic field the Neodymium is mounted in such a way that it is parallel to the rails and as close as possible. Also, keeping in mind that the magnetic field needs to point in one direction, the magnets need to be arranged carefully. In the wiring process, the positive terminal of the battery is attached to switch which is then routed to one rail, and the negative terminal connected directly to the opposing rail. The wires were made of coppers wire. Without the projectile in place there is no current flowing through the apparatus. This is because there is a segment of the loop not connected. Once the magnets, rails, battery, and wiring is all in place the next thing to do is to make sure the projectile is a good fit in the groove that was made for it. Each part must be in a specific orientation with vectors pointing in the correct direction or the machine will not produce any noticeable accomplishments. Lorentz Force is given by $F = I \times B$, where F is the force, I is the current, and B is the magnetic field. Using the right hand rule, that is point figures in the direction of the current then curl toward the magnetic field and the thumb will point in the direction of the Lorentz Force. On the projectile if it is wired exactly like the figure above then on the projectile the current is traveling toward the back rail and the field is pointing up so the force that the projectile feels is in the direction out of the page or toward the end of the rails. That is the basic concept of a railgun. Now there are other projectiles that will work. Tungsten works well, graphite is so light that there is very little contact with the rails (which is an important feature) and it also is very flammable. The melting point for graphite is low compared to Tungsten. Copper is a traditional substance for the rails of a railgun, however the current produced by the battery was too high and that it made a mini-spot welder. The battery that can produce up to18 volts which works; there are many other resources that can be used.

Conclusion:

The construction of the railgun was successful and very informative. Trial and error was the best path in this project. Railguns range from a nail roller to dangerous killing machines. As a wise man said once it is poetic how welding rods are the solution to stop any spot welding issues.

Works Cited:

- Fauchon-Villeplee, Andre Louis Octave. 1922. Electric Apparatus for Propelling Projectiles. U.S. Patent 1,421,435 filed April 1, 1919, and issued July 4, 1922.
- McNab, I.R.; , "Early electric gun research," *Magnetics, IEEE Transactions on* , vol.35, no.1, pp.250-261, Jan 1999 doi:10.1109/20.738413 URL: <http://0ieeexplore.ieee.org.library.uark.edu/stamp/stamp.jsptp=&arnumber=738413&isnumber=15929>
- Babb, Colin "Office of Naval Research U.S. Navy Demonstrates World's Most Powerful Electromagnetic Railgun at 10 MJ", January 31, 2008, accessed , April 2, 2011, <http://www.navsea.navy.mil/nswc/dahlgren/ET/railgun/FINAL_NEWS_RELEASE.pdf>