Rail Guns

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What Are Rail Guns

- 2 rails of conducting metal
- Oppositely charged with a conductor connecting them
- Charge is driven through the conductor
- Magnetic field is produced which accelerates the conductor down the rails
- Enough current and long enough rails yields tremendous force and energy
The Physics

- Rails are oppositely charged
- Driving current between rails through projectile
- Magnetic field is produced that act to accelerate the projectile
The details

- Biot-Savart magnetic field

\[ B(s) = \frac{\mu_0 I}{2\pi} \left( \frac{1}{s} + \frac{1}{d - s} \right) \]

- Lorentz force

\[ F = I d B_{\text{avg}} = \frac{\mu_0 I^2}{2\pi} \ln \frac{d}{r} \]

- Some quick numbers:
  - 10^6 Amps
  - 30 Feet (rails)
  - 10^6 Joules
Similar Idea: A Coil Gun

- Solenoid coils with a current passing through them.
- This magnetic field magnetizes a ferromagnetic projectile.
- Causes a force towards the center of the solenoid.
- The force is attractive on both ends so it means that once the armature has reached the centerpoint, it will experience a braking force (known as suck-back).
- With long coils, there will be a period where no force is exerted on the projectile.
- There are many types of designs each with his advantages and drawbacks.
History of Rail Guns

• The army and navy have long been interested

• The space industry has looked into them

• Small-scale versions are easy to make in a lab though they are of limited use.
Current Rail Guns

• Navy Surface Center Dahlgren Division

  – February 27, 2012
  – 33 MJ shot
  – Range of 110-220 NM (vs 13 NM or 60 NM)
  – 40 lb metal bullet
  – $240 million as of early 2012
Issues with Rail Guns

- Power Supply
- Heating
- Melting
- Repulsion
Sources

• Dailytech.com
  http://www.dailytech.com/Navy+Railgun+Fires+33megajoule+Shot+/article20372.htm
• Science.howstuffworks.com

More Reading:

http://www.globalsecurity.org/military/systems/ship/systems/emrg.htm
http://users.tm.net/lapointe/EMGuns.html
Questions?