Review paper on Electromagnetic Railgun (EMR)

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A B S T R A C T - In this paper, study has been done on the model of the electromagnetic railgun and its working. It is an effort to study and put forth the idea of Lorentz force and its applications in a defense weapon. The railgun can be traced down to a simple model of a wire loop carrying current and its behaviour in an external magnetic field. However, implementing this concept on a practical scale has its own challenges and requirements; which are discussed in this article. The use of an electrically accelerated projectile as a means of destruction is a relatively new concept; and is yet to find its own light; however it has been demonstrated how effective it can prove to be.

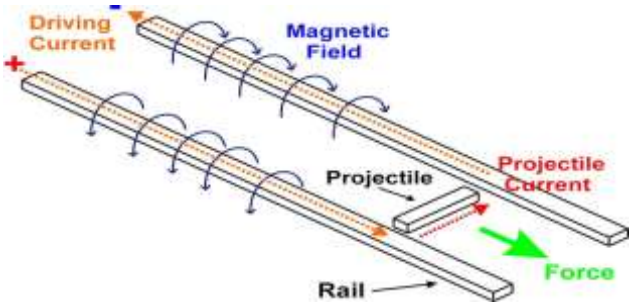
Keywords: ***Armature, Electromagnetic, Kinetic, Lorentz force, Projectile, Railgun, Weapon.***

I. INTRODUCTION

A railgun consists of two parallel metal rails (hence the name). At one end, these rails are connected to an electrical power supply, to form the breech end of the gun. Then, if a conductive projectile is inserted between the rails (e.g. by insertion into the breech), it completes the circuit. Electrons flow from the negative terminal of the power supply up the negative rail, across the projectile, and down the positive rail, back to the power supply.

This current makes the railgun behave as an electromagnet, creating a magnetic field inside the loop formed by the length of the rails up to the position of the armature. In accordance with the right-hand rule, the magnetic field circulates around each conductor. Since the current is in the opposite direction along each rail, the net magnetic field between the rails (**B**) is directed at right angles to the plane formed by the central axes of the rails and the armature. In combination with the current (**I**) in the armature, this produces a force which accelerates the projectile along the rails, always out of the loop (regardless of supply polarity) and away from the power supply, towards the muzzle end of the rails. There are also Lorentz forces acting on the rails and attempting to push them apart, but since the rails are mounted firmly, they cannot move.

Railguns are so called because the projectile is in contact with the conductive barrel, and Electricity being what it is you have a + and a - side, so it rides between two (or an even number) of charged rails. Benefit of railgun is a massive increase in theoretical launch speed, so you have less “flash to bang” (time from firing to target) and higher kinetic energy so can kill with speed instead of having to carry (as much) explosives. Downside is energy is external, generated somewhere and not stored in gunpowder, etc. A railgun shell is much cheaper than a cruise/guided missile, and it doesn’t require a warhead to kill heavily armored targets because of it extremely high kinetic power, eliminating the need for dangerous explosives on board for this particular role. Furthermore their high muzzle velocity could (with the right targeting systems) make them potent in a defensive role, but not as CIWS, more of a stop-gap between them and the Aegis missile defense system. [5]



II. HISTORY

In 2010, the United States Navy tested a BAE Systems-designed compact-sized railgun for ship emplacement that accelerated a 3.2 kg (7 pound) projectile to hypersonic velocities of approximately 2.4 kilometers per second (8,600 km/h approximately 7 times speed of sound), or about Mach 7, with 33-megajoules .

PRINCIPLE

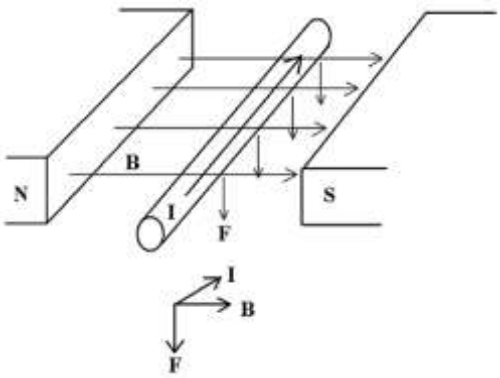
LORENTZ FORCE

According to Lorentz's law, every charge moving in a magnetic field experiences force.
So basically the magnetic field emitted by electrons travelling on the rails propels the projectile.

When a metal carrying an electric current is placed in a magnetic field, it experiences the Lorentz force

- uniform magnetic field of strength { B}
- armature current {I}
- armature length {l},
- the force {F},

$$F = B * I * l \sin\theta$$



A D V A N T A G E S

1) Where missiles can more easily be detected and intercepted by damaging any number of sensitive components or causing an explosion, rail guns can

2) For obvious reasons, you can't use a missile after you have fired it. With proper maintenance, though, a rail gun can be used indefinitely.

3) Projectiles are faster, cheaper and harder to defend against, and take up less space so you can have more ammunition

4) No explosives stored in magazines in the ship. the 'shells' the gun fires are not explosive, so storing them takes far less precautions than regular ammo, and in addition, they are smaller. They can easily be transferred by hand if need be.

D I S A D V A N T A G E S

1) They're heavy. The electromagnets used are very heavy in order to produce the energy to propel the projectile.

2) Power systems. The USN ship-mounted rail gun uses a 25 megawatt power system to fire the gun. Smaller systems are being developed for land deployment via standard military transport vehicles.

3) Limited portability. These weapons will need a transport vehicle to move the heavy gun plus its power systems around the battlespace.

4) They're new. New weapons almost always have some teething issues or create their own unique problems.

5) Unknown human effects of high-energy EM pulse discharges. How the EM gun will affect the health of sailors hasn't been intensively studied. [2]

III. DISCUSSION

F U T U R E S C O P E

DRDO Electromagnetic Railgun :- The Future Weapon of Indian Navy : Rail gun is a weapon capable of launching projectile without the usage of explosives or propellants, but, are launched at extremely high velocities, mach 7 (at sea level) or more. Capability of launching projectiles at velocities higher than guns and cannons makes rail gun hit targets at greater ranges capable of hitting the target with extreme speed and accuracy thus nullifying the escape factor of the enemy platform or an approaching projectile. With the usage of rail gun the hazards of usage of explosives and chemical propellants are evaded as well. [4] [1]

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