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ELECTROMAGNETIC RAILGUN: FROM FICTION TO REALITY

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The Electromagnetic (EM) Railgun, developed by the United States Office of Naval Research (ONR) with BAE Systems, was recently put on display to the public for the first time at the Naval Future Force Science and Technology EXPO at the Walter E. Washington Convention Centre in Washington, D.C. on February 04, 2015.¹ The unveiling of the Innovative Naval Prototype lays down the foundation of a new class of high tech long range weapon system.

The EM Railgun is a weapon system conceived in the year 2005 to fire non-explosive inert projectiles over long ranges.² The testing and evaluation of this weapon system has been continuing in laboratory conditions since past few years. The phase I of the project aimed at development of a reliable launcher resulting in demonstration of 32 mega-joule of muzzle energy has been completed. The phase II of the project started in 2012 with the intention of configuring the system to fire a salvo of projectiles like a machinegun.³ In the present configuration, BAE system is aiming to achieve projectile launch speeds exceeding 7 mach (8575 Km/h) over a range of 160 Km. Adm. Matthew Klunder, Chief of Naval Research describes the capabilities stating "*We're talking about a projectile we're going to send well over 100 miles. We're talking about a projectile that can go over Mach 7. We're talking about a projectile that can go well into the atmosphere. We're talking about a gun that is going to shoot a projectile that is about one-one hundredth of the cost of an existing*



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missile system today".⁴ As per available reports, the field evaluations are planned aboard a fast moving ship in the year 2016.⁵

Basic principle and working⁶

The Railgun works on the principle of converting EM energy into kinetic energy. A basic line diagram of the Railgun is shown in figure 1 for understanding the fundamentals. The EM Railgun comprises a set of parallel rails of a highly conductive metal. On these rails, rests a projectile (which acts as a sliding armature). The system is powered by a captive power supply. The power source could be a capacitor bank or an alternator assembly capable of producing pulsed output resulting in generation of phenomenal amount of power in magnitude of few giga-watts (say in the range of $\sim 10^{10}$ watts).

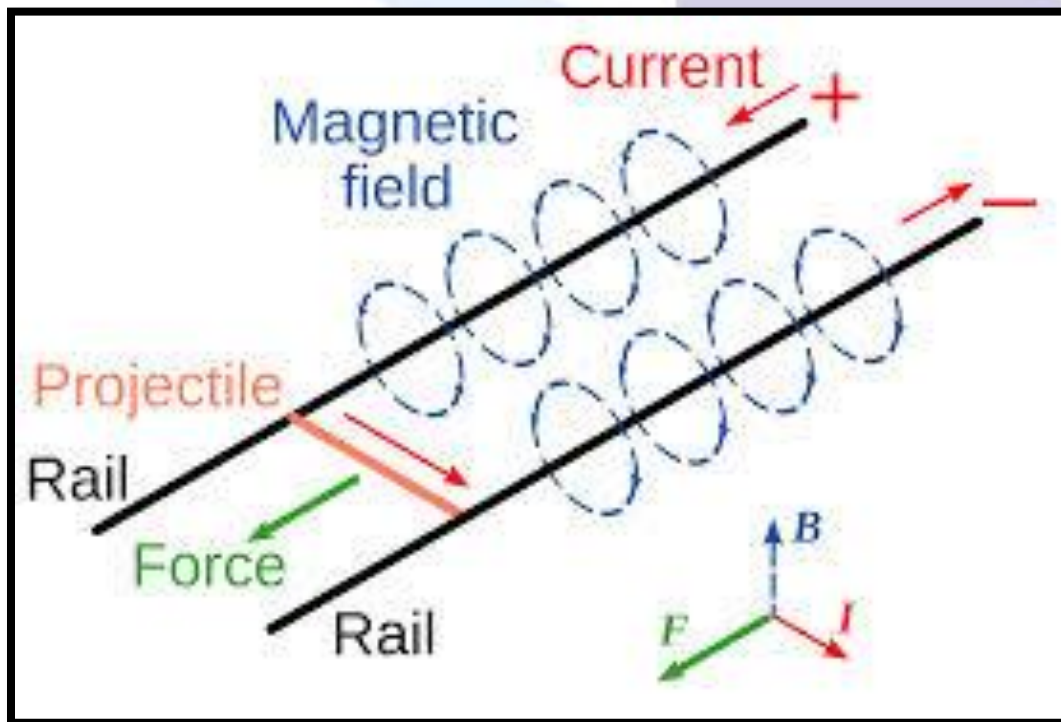


Figure 1. Schematic diagram of a Railgun⁷



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As the power supply feeds the high voltage to the system, the transient current (~ millions of amperes) flows from the positive rail moving across the armature and thereafter to the negative rail (in opposite direction) completing the circuit. The flow of current from the positive to negative terminal is associated with corresponding magnetic fields which then exerts force on projectile in a perpendicular direction. The projectile accelerates under the influence of magnetic field and is released from the turret housing.

What it offers

The evaluation, testing and subsequent induction of EM Railgun in the United States Navy would bring in significant advantages in its force projection capabilities.

- The system will not use any material propellants (chemical, nuclear etc.) and is based on kinetic kill technology. Non usage of chemical or other propellants would eliminate untoward incidences of hazardous explosions and leave no unexploded ordinance in the battlefield. It may absolve the crew of the technologists issues to certain extent.
- Improve the range to target as compared to conventional munitions.
- Weapon would provide for wide area coverage against ground, maritime and aerial targets.
- Salvos of projectile could be fired with improved lethality and accuracy.
- Would provide a flexible and quick response from standoff ranges.
- Provides for a low cost solution when compared to firing of missiles.
- Can be modified for the use of army and air force.
- Can evolve as a launch system for low earth orbit satellites as well as can be effectively used as kinetic weapon against space targets.



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Challenges

The durability and efficiency of overall system will depend on a multitude of factors. First and foremost challenge faced by an EM Railgun is the sustainability of power supply in terms of power generation, energy storage and the ensuing space requirements for the power banks. The technicalities complicate with the design for firing of salvos for destruction of target. The Railgun setup would entail strong heat resistant materials that can uphold high currents, phenomenal heating and cater for a prolonged operational life in adverse environmental conditions. During the firing sequence, the rails would be subjected to enormous repulsive forces and require withstanding them. The resulting wear and tear from these issues would affect the operational lifecycle of the weapon system. Secondly, as the projectile uses kinetic energy, it will be difficult to control or manoeuvre it post firing. While the US navy says that the projectile can be GPS guided,⁸ it does not appear practical owing to phenomenal speed and within the short weapon to target time. Lastly, firing of large projectiles over speeds of mach 7 would generate considerable recoil for the ship to absorb.

Conclusion

Though, the United States has invested considerably in the Railgun project, and has carried out evaluation in simulated laboratory environment, the challenges to sustain the operational capability of such a weapon system over prolonged periods will come to fore only with field evaluations. Use of high end material and composites, capable of withstanding excessive heat and currents, even if prohibitively expensive would open up the possibility of fielding such weapon system as a low cost, extended capability, broad spectrum point defence capability for the US navy in the years to come.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies [CAPS])



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End Notes

¹ Allison Barrie, "US Navy's new 'Star Wars'-style railgun hits Mach 6", at <http://www.foxnews.com/tech/2015/02/05/us-navys-new-star-wars-style-railgun-hits-mach-6/> accessed on February 25, 2016

² "Electromagnetic Railgun", factsheet, Office of Naval Research, at http://www.onr.navy.mil/~media/Files/Fact-Sheets/35/Electromagnetic%20Railgun_Dec%2029%202014.ashx accessed on Feb 23, 2014

³ ibid

⁴ Kris Osborne, "Navy Plans to Test Fire Railgun at Sea in 2016", at <http://www.military.com/daily-news/2014/04/07/navy-plans-to-test-fire-railgun-at-sea-in-2016.html> accessed on February 26, 2015

⁵ "U.S. Navy Railgun Video Shows the future weapon's power, In February see it in person", at <http://www.inquisitr.com/1785202/u-s-navy-railgun-video-shows-the-future-weapons-power-in-february-see-it-in-person/> accessed on February 22, 2015

⁶ "Railgun", at <http://en.wikipedia.org/wiki/Railgun> accessed on February 22, 2015

⁷ ibid

⁸ Kris Osborne, "Navy Plans to Test Fire Railgun at Sea in 2016", at <http://www.military.com/daily-news/2014/04/07/navy-plans-to-test-fire-railgun-at-sea-in-2016.html> accessed on February 26, 2015
