International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

# Electromagnetic Railgun/Coilgun Space Shuttle Launcher

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***Abstract*:- At the present time the launching of satellites/rockets/shuttle in space there are required large amount of fuel, space and human efforts. If we use electromagnetic properties for launching shuttle in space with the use of electronics devices, it will reduce lots of human efforts and it's more reliable. This project aims to make cost-effective and using magnetic properties to reduce the usage of large amount of fuel for the space shuttle launcher. The entire staged rocket launching system employed so far is the non-reusability and the low ratio of the payload to the fuel mass which is overall termed as a propellant mass fraction which is not more than 1% has become a problem in terms of cost and in technicality. And the uplifting thrust required is also less. This problem can be solved by using a new technique based on an electromagnetic railgun space shuttle launching mechanism using electromagnetic force for an acceleration of the projectile. For launching the shuttle in space we are using full bridge rectifier circuit and capacitor bank, from capacitor bank the energy or force passes to the coil gun or rail gun to produces the magnetic force/flux which helps to the projectile launch in the space. In this project we are developing the antinuclear launcher for missile launcher and space shuttle launcher, this works on the Lorentz Force to accelerate a projectile. Due too many advantages and required less space and fuel of electromagnetic launcher, this project can be effectively implemented in Space Centre, Space Transportation System and carried cosmonaut and cargo to Earth orbit or in space.**

***Keywords:- Propellent, Lorentz Force, Magnetic repulsion phenomena, fuel efficient, cost-eficient, Rectifier circuit, Capacitor Bank.***

## I. INTRODUCTION

After the Space Shuttle was reusable of low Earth Orbital spacecraft operated system in 20th century, lots of amount of fuel, space and human efforts required for launching the shuttle in space. After that, the universe of space exploration, the cost for launching a space shuttle is mountainous. To develop launching, economical or cost-efficient, reliable, & the less consumption of propellant, launch and accelerate the space shuttle electromagnetically is proposed of this paper. By using the principle of magnetic levitation spacecraft is launched. The object of the shuttle is made magnetically active with the same polarity of Earth's magnetic field. Constantly the new innovations are replacing old ones because of new modern technology and research. And now it is a modern era for shuttle launching with use Magnetism over conventional energy sources like fuels due to its various advantages like to achieve high muzzle velocities, power conversion efficiency, high speed & torque and low maintenance.

This project of electromagnetic railgun space shuttle launcher, works on the principle of Lorentz force or electromagnetic force. It is a combination of electric and magnetic force on a point charge due to electromagnetic fields. A charge Q moving with a velocity V in an electric field E and magnetic field B experiences a force. In this formula describe the magnetic force on a current carrying wire it's called as Laplace force. The electromotive force in a coil loop moving through a magnetic field an aspect of Faraday's Law of induction, and the force on a moving charged particle. Using a magnetic field generated by electrical energy, a rail gun can accelerate a projectile up to 52, 493 feet (16, 000 meters) per second. And while current rail guns have a maximum range of 14 miles (approximately), coil guns can hit a target 280 miles away in 360 Sec.

In our project a wide-length tube and the object to be fired are placed in the tube. Over the tube, coils are wounded. When the supply is given, the first coil gets energized it tries to attract an object and suddenly object gets attracted towards it. Then the first coil gets de-energized and the second coil is energized, then the object gets attracted towards that second coil. This process of energizing and de-energizing is continued till the object reached to end of tube. The speed of the object can be control by varying supply voltage by a voltage regulator which is connected to coils or rails of a launcher. The moving coil is introduced to as the armature field. A typical induction coil gun has a shorted armature in which current is induced by the changing magnetic flux from the outer coils. The induced armature current interacts with the magnetic field from the outer coils and produces a Laplace force propelling the armature along the guide-way. Each coil is driven by its capacitor bank (12-80V). Capacitors are charged and stored the energy in it & then discharged through the coil at the appropriate time. The rectifier circuit converts an AC supply in pure form of DC and stores energy in capacitors. For control circuit we can use AT89s51 microcontroller it is typically required to operate the device is to power, reset, and a clock. The rail tracks or coil wires are connected to the capacitor to produce a magnetic field and the projectile launch at specific speed or velocity by an electromagnetic force or Lorentz force. The location for the launch of the space shuttle is the area with less gravitational force, to an achieving more velocity, with less use of propellant.

This project can be successfully implemented for various applications. Such as in Space Centre for controlling the operation in space and for carried an astronauts & transportation system in space with a high speed as per our

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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convenience due to use of a magnetic force. And can also be used for aircraft launching.

## II. LITERATURE REVIEW

,"Launch to Space with an Electromagnetic Railgun" published in IEEE Transactions on Magnetics by I. R. McNab Institute for Advanced Technology, University of Technology, Austin, TX, USA.

This paper describes The Electromagnetic antinuclear launcher for missile launching and space shuttle launching, this works on principle of magnetizing and demagnetizing of coil. There is a wide length tube and the object to be fired is placed in tube. Over the tube, coils are wounded. When the supply is given, first coil get energized it try to attract a object and suddenly object get attracted towards it. After attraction the first coil De-energized and suddenly second coil is energized, Then the object get attracted towards that coil. This procedure of energizing and de-energizing is continued tin the object get not reached to last coil, In between this running process the object will get a large force and energy, that the object is fired from the tube with the sound speed and to the decided direction. [1]

"Reluctance Launcher Coil-Gun Simulations and Experiment" published in IEEE Transactions on Plasma Science, By Yafit Orbach, Matan Oren, Aviv Golan and Moshe Einat from Ariel University, Ariel, Israel.

In this paper, the (induction) coil gun is a type of electromagnetic mass launcher that uses the Lorentz force to accelerate a projectile. A coil gun consists of a stack of outer coils forming the "barrel (stator) that generates a magnetic field which pushes a second, coaxial, single coil axially along a guide-way. The moving coil is referred to as the armature. A typical induction coil gun has a shorted armature in which current is induced by the changing magnetic flux from the outer coils. The induced armature current interacts with the magnetic field from the outer coils a produces a Laplace force propelling the armature along the guide-way. [2]

"Design and Implementation of Electromagnetic Rail gun Simulation System based on HLA and VR" published in IEEE International conference on Industrial control and Electronics Engineering (2012) By Ming Yang and Yuwei Hu

In this paper, one solution is the electromagnetic rail gun, or rail gun for short. Using a magnetic field powered by electricity, a rail gun can accelerate a projectile up to 52, 493 feet (16, 000 meters) per second. And while current rail guns have a maximum range of 12 miles, rail guns can hit a target 250 miles away in 360 Sec. [3]

"Magnetic Journey of Space Shuttle" published in Advances in Aerospace Science and Applications, By Ravi Kumar Shakya , Priya Garg, Rishabh Bana and Praveen Raj from Aerospace University, SRM University, Chennai, India.

In this paper it describes under the principle of magnetic levitation, space shuttle is launched and is directed towards North Pole or South Pole. The contributing factors for magnetic launch discussed are magnetic field strength, the location of the launch and the structural design of the space shuttle. The location for the launch of the space shuttle is the area with least gravitational force, helping in achieving extra velocity, with the minimum usage of propellant. [4]

## III. CIRCUIT DIAGRAM

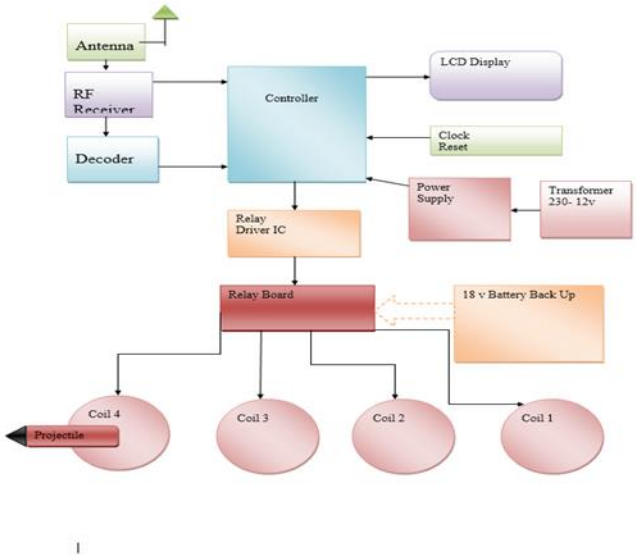


Fig No. 1 Block Diagram

### *A. MICROCONTROLLER*

An embedded AT80s51 microcontroller is an chip that features a processor with all its support functions (clock & reset), memory (both program and data), and I/O (including bus interface) integral into the device.

### *B. RELAY DRIVER CIRCUIT*

ULN2803 The eight NPN Darlington connected transistors during this family of arrays are ideally suited to interfacing between low logic level digital electronic equipment (such as TTL, CMOS, or PMOS/NMOS) and also the higher current/voltage needs of lamps, relays, printer hammers, or different similar masses for a broad vary of computer, industrial, and client applications. All devices feature open collector outputs and freewheeling clamp diodes for transient suppression.

### *C. COILGUN/RAILGUN*

The ohmic resistance of the coils and also the equivalent series resistance (ESR) of this supply are among different limits to the efficiency of a coil gun. The magnetic circuit ideally, 100% of the magnetic flux generated by the coil would be delivered to and act on the projectile, but this is often off from the case due to the common air-core coil construction of most coil guns, which are usually comparatively easy and inefficient designs created by hobbyists. To reduce component size, weight, robustness necessities, and most significantly, cost, the magnetic circuit deliver a lot of energy to the projectile for a given energy input.

### *D. TRANSMITTER and RECEIVER*

For transmitter section, the different commands signals are transmitted via RF transmitter module of 500 MHz it has 4 pins of antenna, Vcc, ground, & serial data input. Antenna, +5v & ground are connected to respective places and serial data input is generated from encoder IC HT12E. This encoder IC's function is to convert parallel data into serial data

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

address lines of encoder are grounded because they are not used.

*E. CAPACITOR BANK*

*A capacitor bank consists a numerous capacitors to stores the energy and supplies to a coil gun or rail gun. In this project each capacitor carries 12V-80V and it's connected to an two end to end terminal of the rail gun circuit.*

*F. RECTIFIRE*

AC supply is connected through rectifier circuit to stores the charge in DC form in capacitor bank with a Zener Diode across it to form pure dc supply. The Transformer is step up the voltage up to 440V and rectifies it through a rectifier circuit.

## IV. PROPOSED METHODOLOGY

This paper represents a space shuttle launching by using electromagnetic principle. Generally, space shuttle launching is done by gave the command to relayed to initiate the space shuttle's three main engines, solid rocket boosters are ignited as the bolts securing the shuttle to the ground are discharged, allowing the rocket launch to propel the spacecraft into the atmosphere. In this process there are required a maximum amount of fuel, space, human efforts and releases gaseous form of pollution. Whereas in electromagnetic principle the power through wounded coils or rail tracks produces magnetic field around it and projectile launches in space by Lorentz force. It has higher reliability and reduced maintenance.

This project introduce to an electromagnetic shuttle launcher. Here we are connecting rectifier circuit to an AC supply (240V-440V) with in series resistor and zener diode connected in parallel /across it. The capacitor bank is for stores the energy in it and supplies when the rail needs a desired voltage level for producing magnetic field. As we can also use Microcontroller AT80s51 for control circuit to reset or control the clock and I/O of the circuit. A digital oscilloscope is connected across the circuit which shows the ripple free dc waveform. This paper presents developing the shuttle launcher by rail gun method. Where the two rail track (aluminum strips) which are made up of aluminum are laid on a thin acrylic sheets, by connecting a thick wire to tracks/strips. We made capacitor bank by using connecting 8 capacitors to each other. A 5v charger and for projectile we used tube bearing. And a rectifier circuit uses to charge the capacitor bank.

When the AC supply converts to pulsating DC by rectifier the pulsating dc voltage is passes thorough zener diode for pure dc voltage, then capacitors are charge and when closes the switch for launching the projectile the supply passes through the aluminum strips or tracks the magnetic field starts generating through it and at the specific amount of kinetic energy through the strips the projectile starts moving towards the end of tracks with an higher velocity and speed by principle of Lorentz force. At the end of tracks there an projectile at its maximum speed and with higher accelerations projectile launches in atmosphere, starts to locates at the orbit. The gravitational factor also affects at the speed of projectile hence the launching place it should be located at less gravitational force (<9.81 m/sec.) The same process we can use in coil gun also for launching the space shuttle but due it's has an less reliability and less speed than rail gun. The flowchart for developed rail gun system is shown in Fig. 2 the workflow of developed rail gun system.

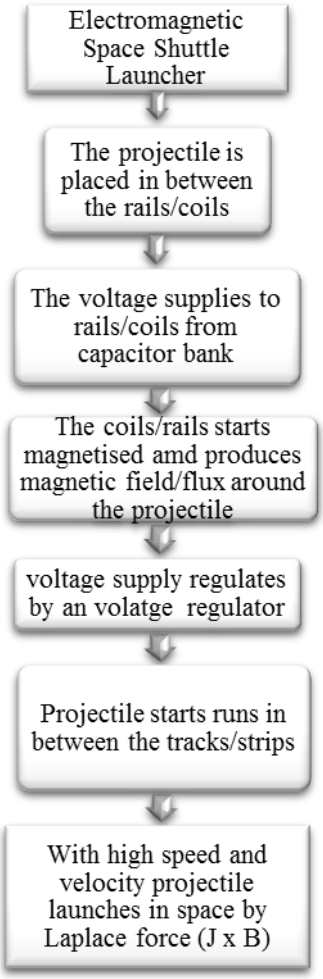


Fig No. 2 The workflow of developed rail gun system

## V. SIMULATION RESULTS FOR RAILGUN CIRCUIT

The voltage regulates in the circuit is by using controller circuit and capacitor bank switch. The simulation results of circuit are as shown in below Fig. 3 when the switch 1 open, Fig 4 shows when the switch 1 is closed. The Digital Oscilloscope is connected across the magnetized tracks and rectifier circuit.

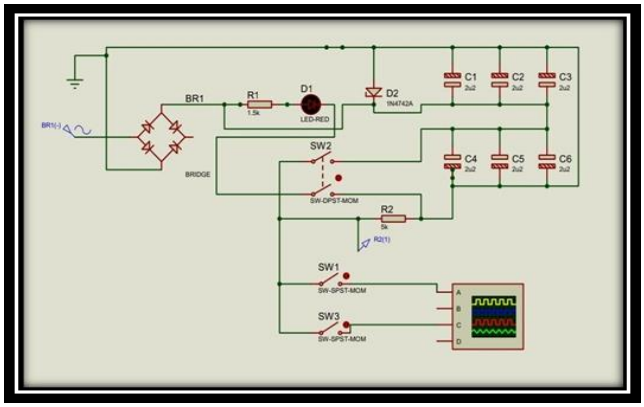


Fig 4. AT switches 1and 2 open in condition

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 06, June-2021

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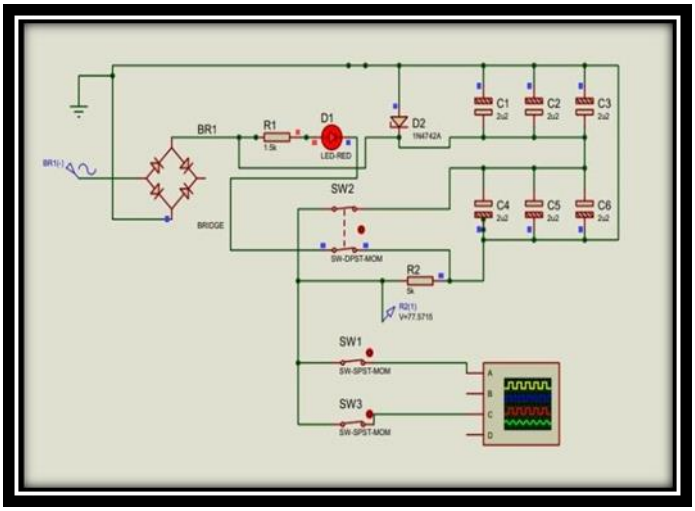


Fig 5. At switches 1 and 2 in close position and projectile starts to run on rail gun and launch in space.

## VI. CONCLUSION

The proposed of system will help to make launching system more reliable, cost-efficient, and less consumption of propellant. The speed of projectile can increase by using coil gun method and for more reliability the rail gun method implanted for space launcher. The use of magnetic field of the earth for the space transportation would revolutionize the launching procedure of the space shuttle, which would in turn improve the efficiency and the reliability of the launching procedure. As the principle of the magnetic levitation is under major application for the railway transportation and space transportation, for astronauts to travel in space is in a completely efficient way. The speed of an projectile or rockets are increased by rail gun method with an very effectively.

## VII. ACKNOWLEDGMENT

We would like to express our sincere thanks to Prof. Iftekar Patel for taking time from his busy schedule to provide us with great deal of help, support and encouragement to work diligently at every aspect of our project.

We are thankful to our college Director Dr. Abdul Razak Honnutagi, Electrical HOD Prof. Rizwan Farade and all staff members of Electrical department for providing us various facilities and guiding us whenever required.

Finally, we would like to thank our parents and our friends for constantly supporting and encouraging our efforts.

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[3] Ming Yang and Yuwei Hu, "Design and Implementation of Electromagnetic Rail gun Simulation System based on HLA and VR" published in IEEE International conference on Industrial control and Electronics Engineering (2012).

[4] Ravi Kumar Shakya , Priya Garg, Rishabh Bana and Praveen Raj, "Magnetic Journey of Space Shuttle" published in Advances in Aerospace Science and Applications (Volume 3, Number 3,2013) pp.167-176.