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Magnetic Accelerator

Dr.G. Raghavendra, Malashree G, Mohan S, Manjunath BP
Electrical and Electronics Department
Sapthagiri College of Engineering,
Bangalore, India
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Abstract— **A magnetic accelerator, also known as a Gauss gun or a coil gun, is a device that uses magnetic fields to propel a projectile at high speeds. This technology has applications in various fields, including military, aerospace, and research. The basic principle involves the use of coils or magnets to create a series of magnetic fields that accelerate a ferromagnetic projectile along a pathway. This abstract provides an overview of the key components, working principles, potential applications, and future developments of magnetic accelerators. Additionally, it explores the advantages and challenges associated with this technology, highlighting its potential for advancing propulsion and launch systems.**

I. Introduction

Magnetic accelerators, also known as coil guns or Gauss guns, represent a fascinating and versatile class of electromagnetic propulsion systems that have garnered considerable interest across various scientific and engineering disciplines. These innovative devices exploit the fundamental principles of electromagnetism to propel projectiles at high velocities, thereby offering potential applications in fields ranging from military and aerospace to advanced research and beyond.

At their core, magnetic accelerators function by utilizing carefully designed arrangements of electromagnetic coils or permanent magnets to generate powerful magnetic fields. These fields are then strategically manipulated to accelerate a ferromagnetic projectile along a predetermined
pathway, ultimately imparting it with significant kinetic energy. This process relies on the interaction between the magnetic fields and the projectile, resulting in a rapid and controlled acceleration that can propel the projectile to remarkable speeds.

The potential applications of magnetic accelerators are broad and diverse. In military contexts, they hold promise for the development of advanced kinetic energy weapons and launch systems, offering the potential for enhanced projectile velocities and ranges. In the realm of aerospace, magnetic accelerators may find applications in the launch and propulsion of spacecraft and satellites, potentially contributing to more efficient and cost-effective space missions. Furthermore, in research and industrial settings, these devices could be utilized for high-velocity impact testing, electromagnetic launch systems, and other specialized applications.

The development and refinement of magnetic accelerators continue to be a focus of ongoing research and innovation. Engineers and scientists are exploring avenues to optimize the efficiency, power, and scalability of these systems, with the aim of unlocking further potential and expanding their practical applications. Additionally, the exploration of novel materials, advanced control systems, and integration with emerging technologies such as electromagnetic propulsion systems and railguns further underscores the dynamic and evolving nature of this field.

As such, this introduction serves as a gateway to the multifaceted world of magnetic accelerators, setting the stage for a deeper exploration of their underlying principles, operational mechanisms, current advancements, and potential future developments. By delving into the intricacies of this captivating technology, a comprehensive understanding of its capabilities and implications can be attained, ultimately illuminating the path for further innovation and application in diverse domains.

II. Literature Survey

In 1934, Ernest O. Lawrence patented a method and apparatus for the acceleration of ions. The invention aimed to produce high-speed ions by subjecting them to successive accelerating impulses in a compact apparatus. The primary concept is to cause ions to travel in curved paths back and forth between a pair of electrodes instead of through a series of electrodes in a rectilinear arrangement. The ions are subjected to an oscillating electric field, and their movement is altered by a magnetic field, causing them to revolve in curved paths in the electric field. The method utilizes resonance between the period of the ions' motion and the frequency of oscillation of the electric field to repeatedly accelerate the ions.

Categorizes electromagnetic launchers as homopolar or heteropolar and explains the advantages of coil guns over railguns, particularly in contactless energy transfer and reduced mechanical stresses. General relationships are derived for both coil guns and railguns, considering the impulsive nature of mechanical, electromagnetic, and thermal stresses.

A detailed idealized model of a coil gun is presented, featuring a polyphase barrel and a sleeve projectile with sinusoidal azimuthal currents. The design is based on a conventional electrical machine model, using planar sheet representations for current distributions and considering the interaction of two systems of azimuthal currents. The design is intended to maintain even stress distribution and high efficiency, crucial for the solid-state integrity of the armature. Departures from the idealized model, including the finite length of barrel coils, end effects, and the acceleration effect on the sleeve, are also discussed. Solutions, such as introducing the projectile with a breech velocity or adjusting the frequency of the current in each coil, are proposed to address these departures. The document concludes by highlighting the need for detailed three-dimensional analyses and power conditioners to ensure synchronization between the projectile and the wave packet, as well as stability. It acknowledges the sponsorship of the work and emphasizes the complexity involved in the complete design process.

In summary, the document provides comprehensive guidelines for designing synchronous-type coil guns, addressing key considerations such as stress distribution, efficiency, and practical limitations for achieving high muzzle velocities. It underscores the importance of detailed analyses and the need for complex controls to ensure successful coil gun design and operation.

Comissioning Tests Of The Medium Caliber Railgun Launcher.

The main findings of the commissioning tests for the Medium Caliber Railgun Launcher (MCL) are as follows:

1. The power supply performed flawlessly.
2. The railgun functioned well, but with a slightly lower than expected inductance gradient.
3. Gouging of the rails was observed at a velocity of 1350 m/s.
4. The highest velocity observed before contact transition was 1970 m/s.

These findings provide a baseline set of armature performance data and highlight the critical issues of rail gouging and contact transition. Such high speeds interaction allowed us to do material study to choose suitable material for the track.

III. Existing System

The only applications used as of now is in the particle accelerators and in coil guns. This provokes the problem of this technology not being completely utilised up to its full potential.

Advantage of Existing System

Not used to full potential as it is a bit expensive, that is the initial cost is high.

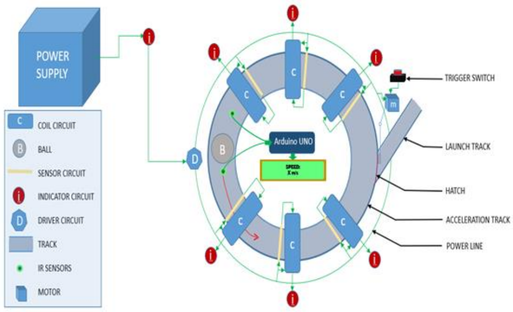
Disadvantage of Existing System

currently only used in large scale only like particle accelerators

IV. Proposed System

- To accelerate a metal ball, a circular magnetic loop is used.
- The ball will get caught in the magnetic field and we have to prevent this.
- A sensor circuit paired with a MOSFET to drive the coil circuit. When the ball reaches a certain point, the sensor triggers a momentary pulse to the coil circuit.
- This occurs when the ball's position is almost close to the coil circuit through which it passes through.
- The coil circuit is shielded with steel to reduce leakage and increase the concentration of the magnetic field.
- When the ball achieves sufficient enough speeds, the ball is launched. The ball here is used as a projectile to hit the targets
- Objective
- Our main objective in this project in to investigate the feasibility and design considerations when it comes to a magnetic accelerator on a larger scale.
- To be able to achieve larger scale of similar principle as a particle accelerator (here size of a small metallic ball). The speed achieved must be considerably high.
- Once the speeds are high enough, the ball is to be launched. Allowing space launches and weaponization of the said technology.

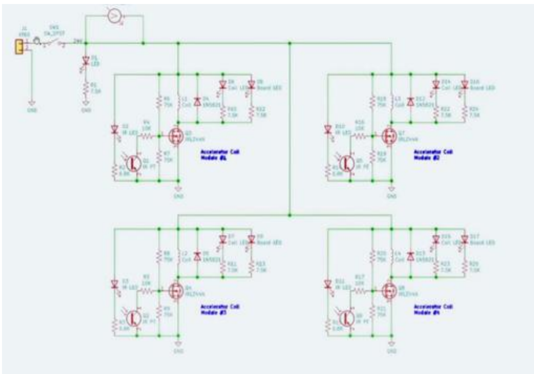
V. System Architecture



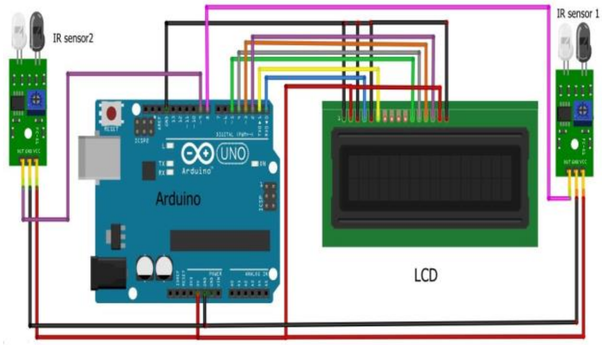
VI. HARDWARE REQUREMENTS

1. 24V Battery.
2. Insulated Copper Wire(coil).
3. MOSFET-IRLZ44N (2.5V THRESHOLD).
4. LED’s.
5. Resistors.
6. Diode – IN5821.
7. Track.
8. Metal Ball.
9. Sluice Door
10. Wire Housing Spool.
11. Metallic Hollowed Discs.
12. Servo Motor(SG90).
13. ARDUINO UNO.
14. IR Sensors.
15. LCD Display.

VII. CIRCUIT DIAGRAM FOR DRIVER CIRCUIT AND COIL CIRCUIT



VIII. CIRCUIT DIAGRAM FOR SPEED CALCULATOR



IX. PROGRAM

```
#INCLUDE <LIQUIDCRYSTAL.H>
CONST INT RS = 12, EN = 11, D4 = 5, D5 = 4,
D6 = 3, D7 = 2;
LIQUIDCRYSTAL LCD(RS, EN, D4, D5, D6, D7);
INT IR1 = 8;
INT IR2 = 9;
UNSIGNED LONG T1 = 0;
UNSIGNED LONG T2 = 0;
FLOAT VELOCITY;
//INT VKMH = (100*3600)/1000;
VOID SETUP()
{
LCD.BEGIN(16, 2);
PINMODE(IR1, INPUT);
PINMODE(IR2, INPUT);
SERIAL.BEGIN(9600);
LCD.CLEAR();
LCD.BEGIN(16, 2);
LCD.SETCURSOR(0, 0);
LCD.PRINT(" SPEED ACHIEVED");}
VOID LOOP()
{
IF (DIGITALREAD(IR1) == 1)
{
T1 = MILLIS();
}
IF (DIGITALREAD(IR2) == 1)
{
T2 = MILLIS();
}
VELOCITY = T2 - T1;
VELOCITY = VELOCITY / 1000; //CONVERT MS TO S
VELOCITY = (0.2 / VELOCITY); // M/S
LCD.SETCURSOR(2, 1);
LCD.PRINT(VELOCITY);
LCD.PRINT(" M/S");
DELAY(500);
}
```

X. APPLICATIONS AND ADVANTAGES

- ➢ In the MEDICAL FIELD:
- X-rays.
- Radiotherapy for targeting cancer cells.
- Helps to create radio-isotopes.
- MRI's.
- ➢ In the RESEARCH FIELD:
- Study of quantum particles.
- Ability to deduce universe's origin.
- ➢ MILITARY PURPOSES:
- Rail guns.
- Energy beams.
- ➢ SPACE VENTURES:
- To launch payloads for a cheaper cost.
- Once constructed launch costs reduce by 70%.

XI. Results and Conclusion

By employing the proposed model, we can optimize space travel in a smart way by minimize the energy based upon the passive travel level, we can control speed automatically through advanced processors. The prototype model demonstrates that the said technology could be weponised and space travel is at most efficient form. Since most of the weight is shed for the projectile to be launched and the fuel weightage is saved The Proposed prototype clearly demonstrates that the Launch system used in day-today provide maximum efficiency. All this amounts to energy savings and better standards of living in today's modern world and also revolutionize space ventures and military.

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