An Project Report

on

DESIGN AND FABRICATION OF A SOLENOID ENGINE

THIRD YEAR OF ENGINEERING
(Mechanical Engineering)

Submitted by:

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Under the guidance of

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Certificate

This is to certify that the following group of bonafide students from the Department of Mechanical Engineering, have successfully completed the prerequisites as laid down by the Savitribai Phule Pune University, Pune in the form of an In Project report at ***"DESIGN AND FABRICATION OF A SOLENOID ENGINE"*** as per the course structure for the Project

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ACKNOWLEDGMENT

I would like to express my sincere gratitude and appreciation to all those who have supported and guided me throughout the successful completion of this project titled **"Design And Fabrication Of A Solenoid Engine."** This project has not only enhanced my technical knowledge but also provided me with a deeper understanding of practical engineering challenges and their innovative solutions.

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Vishal Shinde

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INTRODUCTION

In the modern era of technological advancement, the growing need for sustainable and energy-efficient alternatives to conventional internal combustion engines has become more pressing than ever. Traditional engines, while powerful and widely used, are dependent on fossil fuels and contribute significantly to air pollution, noise, and global carbon emissions. In light of these concerns, the development of electromagnetic engines presents a promising pathway toward cleaner and more eco-friendly power systems. One such innovative approach is the solenoid engine, a device that uses electromagnetic principles to generate motion without the need for combustion.

A solenoid engine operates using the basic principle of electromagnetism, where electrical energy is converted into mechanical motion through the use of solenoids—electromagnetic coils that produce a magnetic field when current passes through them. Unlike traditional engines that rely on combustion to push pistons and turn a crankshaft, a solenoid engine utilizes electromagnetic attraction to move a plunger or armature within a coil, thereby creating linear motion. This motion can then be converted into rotary motion using a crankshaft mechanism, making it suitable for practical applications that require rotational power.

The objective of this project, titled "Design and Fabrication of a Solenoid Engine," is to design a working model of a single-cylinder solenoid engine that demonstrates the fundamental working principle of electromagnetic propulsion. This project aims to explore an alternative method of engine design that eliminates the need for fossil fuels, reduces noise pollution, and minimizes mechanical wear and tear. The solenoid engine model will serve as a proof of concept, showcasing how electromagnetic force can be harnessed effectively to create motion.

The solenoid engine developed in this project is constructed using readily available materials such as solenoid coil wire, a ferromagnetic plunger (shaft), flywheel, bearings, limit switch, and a 12V DC power supply. The design incorporates a mechanism to convert the linear motion of the solenoid into rotary motion, similar to that of a crankshaft system found in internal combustion engines. Proper timing and switching of the current are essential to ensure smooth and continuous operation, and this is achieved using a limit switch that acts as a mechanical controller.

The educational value of this project lies in its demonstration of the practical application of basic electrical and mechanical engineering principles. It bridges the gap between theoretical knowledge and real-world application, offering students an opportunity to develop a hands-on understanding of electromagnetic propulsion systems. Furthermore, it promotes innovative thinking by encouraging exploration of alternative energy solutions and sustainable technologies.

This project also highlights key advantages of solenoid engines, including lower maintenance requirements due to fewer moving parts, reduced operational noise, and zero exhaust emissions. While solenoid engines are not yet viable replacements for high-power engines in automobiles or industry, they offer valuable insight into the future of green engineering and serve as an excellent foundation for further research and development in the field of electromechanical systems.

In conclusion, the **"Design and Fabrication of a Solenoid Engine"** project not only introduces an environmentally friendly method of generating motion but also encourages experimentation and innovation in the field of mechanical and electrical engineering. Through careful design, construction, and testing, this project aims to showcase the potential of solenoid-based engines and contribute to the broader discussion on sustainable engineering practices.

Components Used in the Project:

1. Solenoid Coil Wire
2. Shaft
3. Flywheel
4. Bearings (6mm ID)
5. Limit Switch (12V)
6. Base Frame
7. Power Supply (12V DC Adapter)
8. Screws, Nuts & Fasteners
9. Connecting Wires
10. Mounts/Brackets
11. Enclosure Cover
12. Miscellaneous

OBJECTIVE

The primary objective of this project is to design, develop, and fabricate a working model of a solenoid engine that demonstrates the principles of electromagnetic propulsion as a potential alternative to conventional internal combustion engines. This project aims to provide a sustainable and eco-friendly mechanical system that can convert electrical energy into mechanical motion using solenoids, thus eliminating the dependence on fossil fuels.

The project focuses on integrating fundamental concepts of electrical, mechanical, and electromagnetic engineering to create a compact engine prototype driven entirely by solenoid coils. The ultimate goal is to illustrate how linear motion generated by an electromagnetic field can be converted into rotary motion for mechanical work. The proposed solenoid engine model serves both as an educational tool and as a foundation for further research in the development of cleaner energy technologies.

This project also emphasizes the use of readily available, low-cost materials and components to ensure affordability, accessibility, and reproducibility in academic settings. By constructing a working prototype, the project encourages students to gain hands-on experience in fabrication techniques, motion conversion mechanisms, circuit assembly, and system integration.

The key objectives of the project are as follows:

1. To understand and apply the working principles of solenoids
   Analyze how electromagnetic fields can be used to produce mechanical force using solenoid coils.

2. To design a simple and functional single-cylinder solenoid engine
   Develop a mechanical design that effectively converts linear motion into rotational motion using shafts, bearings, and a flywheel.

3. To fabricate the engine using accessible materials
   Utilize standard mechanical components such as shafts, brackets, bearings, and fasteners, combined with solenoid wiring and electrical connections.

4. To implement a control mechanism using a limit switch
   Integrate a 12V limit switch to manage the on/off timing of the solenoid coil for continuous and smooth operation.

5. To demonstrate the potential of electromagnetic propulsion systems
   Showcase the effectiveness of solenoid-based actuation in driving mechanical systems with minimal noise and no fuel-based emissions.

6. To evaluate performance and identify potential improvements
   Observe the operational characteristics of the engine prototype, identify efficiency bottlenecks, and suggest design optimizations for future versions.

7. To promote environmental awareness and innovation
   Encourage the exploration of cleaner alternatives to traditional engines, contributing to the global shift toward sustainable and renewable technologies.

By achieving these objectives, the project not only reinforces academic knowledge through practical implementation but also stimulates interest in green engineering and alternative propulsion methods. It reflects a growing global need for energy-efficient technologies that can reduce environmental impact while maintaining mechanical performance.

The "Design and Fabrication of a Solenoid Engine" project represents a forward-looking initiative that bridges academic theory with practical application. It empowers students to innovate, build, and think critically about the future of energy and mechanical systems.

METHODOLOGICAL DETAILS

The methodology for this project is structured in a step-by-step approach to ensure systematic planning, design, development, and testing of a working solenoid engine. This section elaborates on the engineering methods and fabrication techniques used to build the solenoid engine prototype, integrating mechanical and electrical elements to produce a functional electromechanical system.

1. Conceptualization and Research

The first stage of the project involved studying the working principle of solenoids and their capability to convert electrical energy into linear mechanical motion. Detailed research was conducted to understand how the solenoid can be used as the driving force in an engine setup, replacing the role of combustion in traditional engines.

Key learning areas included:

- Electromagnetic induction
- Conversion of linear motion into rotary motion
- Mechanical load balancing and inertia via flywheels
- Switching mechanisms and timing control

A review of existing small-scale solenoid engine models, online tutorials, and academic resources was done to finalize a simple, functional design.

2. Design and Planning

A basic schematic of the engine was created, considering the layout of components, including:

- The position of the solenoid coil
- Shaft alignment and flywheel positioning
- Placement of bearings for rotational support
- Mounting brackets and base frame configuration
- Wiring layout and limit switch positioning

Design planning also included torque calculations, solenoid coil dimensions (number of turns, wire gauge), and the stroke length required to rotate the flywheel sufficiently.

Software tools like AutoCAD or SolidWorks were optionally used to create a 2D/3D visualization for precise component alignment.

3. Component Selection

The following components were finalized and sourced based on their availability, compatibility, and performance:

- Solenoid Coil Wire: Enamelled copper wire, wound to form an electromagnet.
- Shaft: A ferromagnetic rod (typically steel) to act as the moving plunger inside the coil.
- Flywheel: Small metallic disc to maintain momentum and rotational smoothness.
- Bearings (6mm ID): To support the shaft and reduce friction during rotation.
- Limit Switch (12V): Acts as a mechanical sensor to control the coil's energizing timing.
- Base Frame: Wooden or metallic frame to support all components.
- Power Supply (12V DC Adapter): Stable power source to energize the solenoid.
- Screws, Nuts & Fasteners: Mechanical fixtures for assembly.
- Mounts/Brackets: For securing the solenoid coil and shaft assembly.
- Connecting Wires: For establishing the electrical circuit.
- Enclosure Cover & Miscellaneous: Protection, insulation, and finishing.

4. Fabrication Process

- Coil Winding:
  The solenoid coil was wound using enamelled copper wire over a hollow cylindrical tube or PVC pipe, forming the electromagnetic actuator.
- Shaft Preparation:
  A cylindrical steel rod was cut to the required length and polished to minimize friction. The shaft was designed to move freely inside the coil without sticking.
- Base Assembly:
  The base was assembled using wood or metal. Mounting holes were drilled to install the solenoid, flywheel, shaft supports, and limit switch.
- Flywheel Attachment:
  A lightweight flywheel was attached to the shaft to accumulate momentum during operation and support consistent rotation.
- Bearings and Supports:
  The shaft was passed through precision bearings, mounted on both sides of the base using brackets to ensure smooth and aligned rotation.
- Electrical Circuitry:
  The power supply was connected through the limit switch to the solenoid coil using connecting wires. The limit switch was placed strategically to activate and deactivate the coil during each cycle of the shaft's motion.

5. Circuit Integration and Testing

The circuit was tested using a 12V DC adapter. When the shaft was manually rotated and the limit switch engaged, the solenoid was energized, pulling the shaft into the coil and producing forward linear motion. The flywheel helped carry the shaft through its return cycle.

Multiple test cycles were performed to:

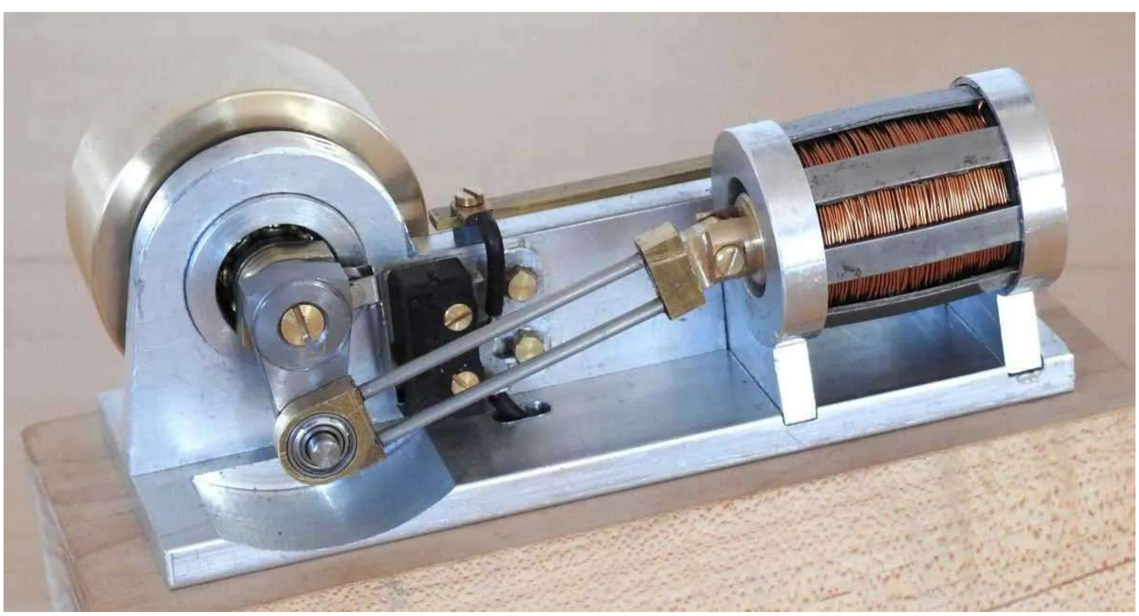
- Adjust the placement of the limit switch for proper timing
- Check the solenoid pull force and coil heating
- Minimize mechanical friction in bearings and flywheel

6. Final Adjustments and Optimization

After initial testing, several refinements were made:

- Adding return springs to help the shaft retract
- Adjusting flywheel weight to optimize rotational inertia
- Reinforcing the base for vibration dampening
- Heat shielding or insulation for the coil
- Using rubber washers to reduce electrical noise and mechanical vibrations

The final assembly resulted in a small-scale, functional solenoid engine capable of demonstrating continuous rotary motion powered by electromagnetic force alone.



ROLE IN MODEL

Detailed Component Roles:

1. Solenoid Coil Wire

- Function: Acts as the heart of the engine.
- Role: When electrical current passes through the coil, it generates a magnetic field. This magnetic field pulls the ferromagnetic shaft (plunger) into the coil, producing linear motion that serves as the "power stroke" of the engine.

2. Shaft (Plunger)

- Function: Translates magnetic force into mechanical motion.
- Role: The shaft moves back and forth inside the solenoid coil. As it moves forward (into the coil) due to magnetic pull, it is linked to the flywheel to create rotary motion. It is often made of iron or steel for magnetic interaction.
-

3. Flywheel

- Function: Maintains momentum and stores rotational energy.
- Role: Attached to the shaft, the flywheel helps smooth out the intermittent motion caused by solenoid activation. It keeps the shaft moving during inactive periods of the solenoid, simulating engine inertia and enabling continuous rotation.

4. Bearings (6mm ID)

- Function: Support rotational movement with minimal friction.
- Role: The shaft is supported by these bearings, allowing it to rotate freely. They help reduce wear and energy loss due to friction and ensure alignment during motion.

5. Limit Switch (12V)

- Function: Controls the timing of the coil energizing.
- Role: It turns the solenoid on and off at the correct time in each cycle. When the shaft reaches a specific position, the limit switch closes the circuit and energizes the solenoid to start the next stroke.

6. Base Frame

- Function: Provides structural stability.
- Role: All components (coil, shaft, flywheel, brackets) are mounted on the base frame. It holds everything in place, ensuring the alignment and integrity of the engine structure during operation.

7. Power Supply (12V DC Adapter)

- Function: Supplies electrical energy.
- Role: Provides the necessary voltage and current to energize the solenoid coil and operate the limit switch. A stable 12V DC supply ensures safe and consistent engine performance.

8. Screws, Nuts & Fasteners

- Function: Assembly and securing.
- Role**:** These components are used to attach the coil, shaft supports, brackets, and limit switch firmly to the base frame. They ensure the mechanical structure remains intact during operation.

9. Connecting Wires

- Function: Transmit electrical signals.
- Role**:** Connect the power source to the solenoid and the limit switch. Proper insulation and layout prevent short circuits and ensure a safe, closed-loop circuit.

10. Mounts/Brackets

- Function: Hold components in place.
- Role**:** Secure the solenoid coil and bearings in the desired orientation. Proper mounting is essential to avoid vibration and misalignment.

11. Enclosure Cover

- Function: Safety and protection.
- Role**:** Encloses the engine setup to protect users from moving or hot parts and prevent dust or debris from interfering with operation. It adds both safety and professional presentation.

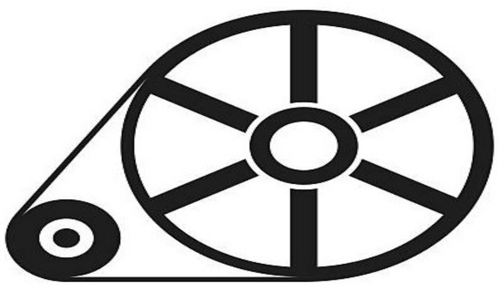
12. Miscellaneous Items

- Function: Supportive roles and final adjustments.
- Role**:** These components enhance durability, ease of operation, and aesthetics. For example, a return spring can help pull the shaft back when the coil is off.
- Examples: Includes washers, springs, spacers, heat shrink tubing, adhesives, etc.

Solenoid Coil Wire

Shaft

Flywheel



Bearings

Limit Switch (12V)

12V DC Adapter

WORKING

The working of the solenoid engine is fundamentally based on the principle of electromagnetism, where electrical energy is converted into mechanical motion. The engine utilizes a solenoid coil, which, when energized with a 12V DC power supply, generates a magnetic field. This magnetic field pulls a ferromagnetic shaft or plunger into the centre of the coil, creating a linear motion. This linear motion is then used to generate rotary motion with the help of a mechanical assembly that includes a flywheel and shaft system. The entire setup effectively transforms electrical energy into mechanical energy without the use of conventional fuels, making it a cleaner and environmentally friendly alternative.

In this project, the solenoid coil is the primary driver of movement. When the coil is powered, the magnetic field generated within it pulls the shaft forward. This shaft is mounted through 6mm ID bearings, which allow for smooth, low-friction movement. The shaft is connected to a flywheel, a mechanical device that stores kinetic energy and helps maintain continuous motion. As the shaft is pulled into the coil, it causes the flywheel to rotate. The energy stored in the rotating flywheel helps push the shaft back once the power to the solenoid is turned off.

To control this motion, a limit switch is used to detect the shaft's position. Once the shaft reaches the end of its stroke, the limit switch activates, cutting the power to the solenoid. This stops the magnetic field and allows the shaft to return to its original position. The return motion can be assisted by the flywheel’s inertia or a spring mechanism. As the shaft moves back, it resets the limit switch, reactivating the solenoid. This creates a repeating cycle of shaft movement, generating continuous rotary motion. The speed and smoothness of this motion depend on the timing of the switch and the efficiency of the flywheel system.

The components are all mounted securely on a base frame using mounts, brackets, nuts, bolts, and fasteners. These provide structural integrity and proper alignment of moving parts. Connecting wires are used to deliver electrical power from the 12V DC adapter to the solenoid and control components. A protective enclosure cover is used to shield the internal parts from dust and accidental contact, enhancing safety during operation.

The complete operation of the solenoid engine showcases a fundamental method of converting electrical energy into mechanical work. Although this prototype operates at low power, it effectively demonstrates the potential of solenoid-based systems for small-scale applications. The absence of fuel, combustion, and emissions makes it a clean and sustainable model. It serves as a useful educational project, offering insight into electromagnetic propulsion, mechanical linkages, and energy conversion, and lays the groundwork for more advanced developments in eco-friendly engine design.

BLOCK DIAGRAM

Power Supply

(12V DC)

|

Solenoid Coil

|

Electromagnetic Force

|

Shaft

|

Flywheel

|

Bearings

(6mm ID)

|

Base Frame

Mount Brackets

|

Limit Switch (12V)

|

Controls Current to Solenoid

|

Connecting Wires, Screws & Fasteners

|

Enclosure Cover

SCOPE FOR THE FUTURE WORK

The current project successfully demonstrates the basic working principle and construction of a single-cylinder solenoid engine as an alternative, eco-friendly power-generating mechanism. However, the prototype leaves significant room for enhancements and scaling. This section outlines various avenues for future work that can improve the functionality, efficiency, and practicality of solenoid engine technology for real-world applications.

1. Multi-Cylinder Configuration

One of the most impactful future enhancements would be the design of a multi-cylinder solenoid engine. Similar to traditional internal combustion engines, multiple solenoids could be arranged in series or parallel to deliver higher torque and smoother rotational output. By controlling the timing and phasing of each solenoid's activation, continuous motion with reduced vibration can be achieved. This configuration would enable the solenoid engine to power small-scale machinery or lightweight electric vehicles.

2. Pulse Width Modulation (PWM) and Automation

Currently, the solenoid is controlled using a mechanical limit switch. Future designs can incorporate PWM (Pulse Width Modulation) control using microcontrollers such as Arduino, Raspberry Pi, or custom PCBs. This would allow for:

- Precise control of solenoid activation timing
- Adjustable speed and force of the actuator
- Real-time feedback and automated performance tuning

By integrating sensors and embedded systems, the solenoid engine could operate efficiently under various load conditions.

3. Energy Efficiency Improvements

The present setup consumes a significant amount of electrical energy for relatively low mechanical output. Future work could focus on:

- Using high-efficiency solenoids with better coil designs (multi-layer winding, core materials with higher magnetic permeability)
- Heat management systems to reduce losses from coil heating
- Energy recovery systems, such as regenerative braking or storing kinetic energy in supercapacitors

Improving the energy-to-motion conversion ratio is critical for the broader adoption of solenoid engines.

4. Materials and Lightweight Design

Optimization of materials can significantly reduce the weight and cost of the solenoid engine. Future projects may investigate:

- Use of lightweight alloys or 3D-printed parts for the frame and flywheel
- Development of composite coils with high magnetic performance
- Miniaturization of components without compromising power output

These advancements would make the engine suitable for portable and embedded applications.

5. Application-Specific Customization

With further development, solenoid engines can be tailored for specific applications such as:

- Educational kits for learning electromagnetism and mechanical systems
- Compact actuators in robotics and automation
- Energy-efficient fans, pumps, or small conveyor belts in industrial settings
- Emergency backup systems powered by battery-operated solenoids

By designing modules that meet niche application requirements, the utility and market potential of solenoid engines can be increased.

6. Integration with Renewable Energy Systems

Future enhancements could involve integrating the solenoid engine with solar panels or other renewable energy sources. This would allow:

- Continuous operation without dependency on the grid
- Demonstration of completely green energy generation and utilization
- Applications in off-grid areas or remote sensing devices

Such developments align the project with global sustainability goals.

7. Advanced Control and Monitoring Interface

A real-time monitoring dashboard can be developed using IoT technology. This interface would:

- Display operational parameters (voltage, current, RPM, temperature)
- Allow remote control and diagnostics
- Trigger automatic shutdowns or warnings in unsafe conditions

This would add professional and commercial value to the engine design.

CONCLUSION

The project titled **"Design and Fabrication of a Solenoid Engine"** was undertaken with the objective of exploring alternative methods of mechanical power generation that are cleaner, quieter, and environmentally friendly compared to conventional internal combustion engines. Through the conceptualization, design, development, and testing of a single-cylinder solenoid engine, this project successfully demonstrated the basic working principles of electromagnetic propulsion in a practical, functional prototype.

At the core of this project lies the principle of electromagnetism—specifically the interaction between electric current and magnetic fields to produce motion. By utilizing a solenoid coil, ferromagnetic shaft, and a flywheel system, the engine converts electrical energy into reciprocating motion, which is then converted into rotary motion. The use of a 12V DC power supply makes the system safe and convenient for educational and low-power applications. The design included essential mechanical and electrical components such as limit switches, bearings, brackets, and a stable base frame—all of which contributed to the overall reliability and operability of the engine.

The fabricated engine performed according to expectations during no-load conditions. The limit switch effectively controlled the timing of solenoid activation, enabling the reciprocating shaft to mimic piston-like movement. The flywheel helped to stabilize and continue the rotation during intervals when the solenoid was not energized, which closely resembles the concept of momentum in conventional engines. The successful functioning of this prototype illustrates the potential of solenoid-based systems as viable alternatives in certain domains.

However, the project also highlighted some limitations. The energy efficiency was relatively low, and the electromagnetic force generated by the coil was sufficient only for light-duty applications. Additionally, the system demonstrated heating issues in the coil during extended use, and the mechanical wear of the limit switch suggested the need for electronic control alternatives in future iterations. These limitations are significant in terms of scaling the system for real-world applications, yet they also present valuable learning opportunities for future research and development.

From an academic standpoint, this project provided a solid foundation for understanding electromechanical systems, energy conversion, timing mechanisms, and basic principles of engine operation. It also encouraged hands-on skills in fabrication, wiring, assembling, and troubleshooting. The real-world exposure to designing a working model from scratch enhanced technical skills while promoting teamwork, problem-solving, and engineering decision-making.

In conclusion, this solenoid engine project serves as a stepping stone toward developing sustainable and intelligent mechanical systems. With future advancements such as microcontroller integration, optimized coil design, thermal management, and multi-cylinder configurations, solenoid engines may find their niche in specialized fields such as educational tools, robotics, small-scale automation, and portable energy devices. The project successfully met its objectives and has laid the groundwork for future exploration and innovation in electromagnetically-driven engines.


Solenoid engine