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Electromagnetic Based Vehicle Conversion Kit

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Abstract: IC engines are widely used in vehicles and power generation, but they have several drawbacks. IC engines convert only about 25-30% of the chemical energy in fuel into mechanical energy. The rest of the energy is lost as heat, which can reduce fuel efficiency and increase emissions. IC engines produce a variety of harmful emissions, including carbon monoxide, nitrogen oxides, and particulate matter. These emissions can contribute to air pollution and climate change. IC engines can be noisy and produce vibrations, which can be uncomfortable for passengers and can also damage other components in the vehicle. These drawbacks of IC engines have led to a growing demand for alternative propulsion technologies, such as electric vehicles and hydrogen fuel cell vehicles.

This project aims to develop and build an electromagnetic engine conversion kit that can be used to convert a conventional internal combustion (IC) engine to an electromagnetic engine with minimal replacement parts. Electromagnetic engines use the principles of magnetic repulsion and attraction to generate rotational motion. They offer several advantages over traditional IC engines. Electromagnetic engines are more efficient than IC engines, meaning that they can convert more of the input energy into mechanical energy. This results in better fuel economy and reduced emissions. Electromagnetic engines do not produce any harmful emissions, making them a more environmentally friendly option than IC engines.

The proposed electromagnetic engine conversion kit will be designed to be compatible with a wide range of IC engines. It will consist of a set of copper coils, magnets and a controller. The coils will be mounted on the custom-made engine block and will be used to create a magnetic field. The controller will be used to regulate the current to the coils and to synchronize the magnetic field with the movement of the engine pistons.

The conversion kit is expected to be relatively easy to install and will not require any major modifications to the existing engine. Once installed, the conversion kit will allow the engine to operate in the same way as a traditional IC engine, but with the improved efficiency, cleanliness, and reliability of an electromagnetic engine. This project has the potential to make a significant contribution to the development of more sustainable and environmentally friendly transportation technologies.

Keywords: Electromagnetic, Top dead centre, Bottom dead centre, Magnetism.

I. INTRODUCTION

In the contemporary landscape of global energy consumption, the relentless reliance on fossil fuels has become an undeniable concern. As our planet grapples with the escalating challenges of climate change, environmental degradation, and finite resource depletion, there is an urgent need to explore and implement alternative sources of energy. The traditional dependence on fossil fuels, such as coal, oil, and natural gas, not only contributes significantly to greenhouse gas emissions but also poses severe risks to ecological balance and human health.

There has never been a greater need to look for alternative ways to meet our energy demands. If we keep going in the same path, there will be significant impacts on the environment, political instability, and socioeconomic inequality. Acknowledging the urgent necessity of a change, countries, sectors, and people as a whole are focusing more and more on renewable and sustainable energy sources.

This introduction sets the stage for an exploration into the multifaceted reasons behind the demand for alternatives to fossil fuels. From environmental sustainability to energy security and technological innovation, the quest for viable substitutes underscores a collective responsibility to ensure a sustainable and resilient future for generations to come. As we embark on this journey towards a cleaner and more sustainable energy landscape, it is imperative to analyse the driving forces compelling us to embrace alternatives and usher in a new era of energy innovation.

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II. WORKING

Magnetism, a fundamental force of nature, is a captivating phenomenon that manifests in the attraction or repulsion between magnetic objects. At its core, magnetism arises from the alignment of atomic and molecular magnetic moments within a material, resulting in the creation of a magnetic field.

Repulsion, a distinctive aspect of magnetism, is observed when like magnetic poles face each other. According to the fundamental principle of magnetism, identical poles repel each other due to the attempt to minimize the energy associated with the magnetic field. This phenomenon is eloquently captured by Coulomb's Law for magnetism, which states that the force between two magnetic poles is directly proportional to the product of their strengths and inversely proportional to the square of the distance between them.

Repulsion plays a pivotal role in various technological applications, such as maglev (magnetic levitation) systems, where repulsive magnetic forces are harnessed to suspend objects without physical contact. Additionally, it underlies the functionality of magnetic bearings, offering frictionless support in rotating machinery.

In addition to advancing technology, the study of magnetism and its properties helps to clarify the enigmatic forces that control matter's behavior in the magnetic domain and reveals the complex dance of subatomic particles. This fascinating interaction between attraction and repulsion is still being studied and explored in everyday applications as well as scientific studies.

III. COMPONENTS

The components are separated into three main subassemblies in order to segregate the systems:

- Mechanical System
- Electrical System
- Magnet

A. Mechanical System

The mechanical system consists of:

1. Piston: Depending on the proportions of the car, it is made of non-magnetic materials like aluminium. Considering that the new dimensions have a decreased thickness to account for the permanent magnet that will be placed on top of it. This results in a reduction in the piston’s strength relative to the original, but it makes up for the weakness by thickening the piston shell.

2. Cylinder Head: An electromagnetic engine runs solely on magnets. Unwanted magnetic fields and other losses must be addressed by the cylinder. The substance itself shouldn’t be drawn to the magnet and obstruct the piston’s motion. The cylinder can only be composed of non-magnetic materials, such as titanium, stainless steel, or other materials with low electrical conductivity and high resistivity. An electromagnetic engine’s cylinder is a straightforward rectangular block with a blind hole in it. Since the temperature within the electromagnetic engine cylinder is so low, heat transfer is accomplished without the use of fins. This facilitates the cylinder’s manufacturing process. Additionally, the metal used to make the cylinder is non-magnetic, which restricts the magnetic field inside the cylinder’s perimeter. In contrast to internal combustion engines, which use cast-iron cylinders, aluminium engines are lighter.

3. Crankshaft: The piston’s reciprocating action is transformed into usable rotary motion, which is then transferred to the output shaft. It connects the connecting rod to shaft of output.

4. Connecting rod: The connecting rod’s purpose is to join the piston and crankshaft. Since the cylinder is anticipated to hold the entire magnetic field within it, the connecting rod’s substance won’t be significantly impacted by the magnets. Therefore, the connecting rod is not much altered.

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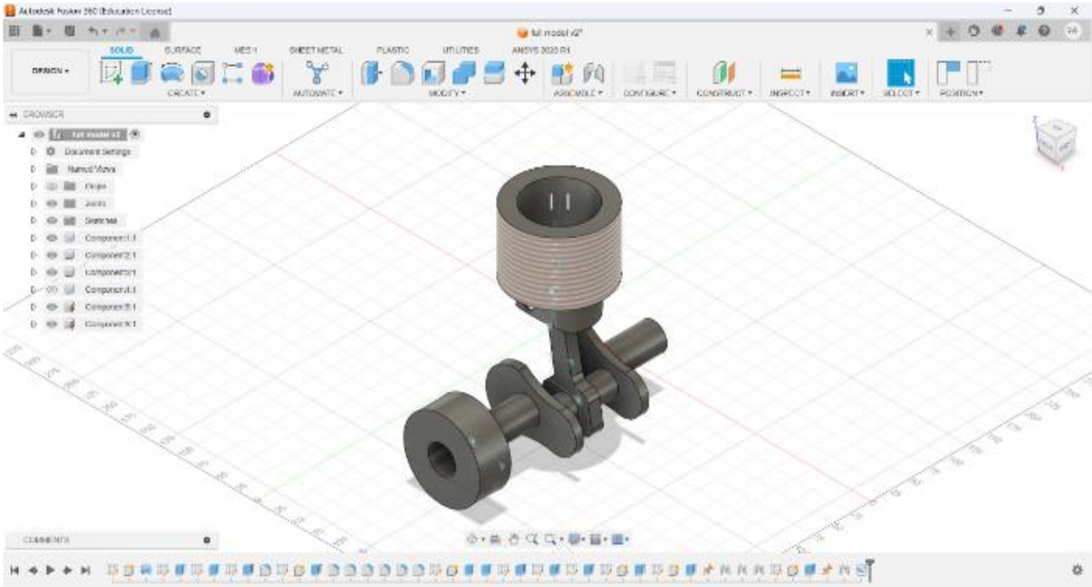

Fig.1 Fusion 360 Engine model

B. Electrical System

The electrical system consists of:

1. Electromagnet: An electric current flowing in a wire creates a magnetic field around the wire and to concentrate the magnetic field, an electromagnet which is copper wire is wound into a coil with many turns lying side by side. The magnetic field of all the turns of wire passes through the centre of the coil, creating a strong magnetic field there. An electromagnet is a conductor that carries current and generates when charged, magnetism. Nonetheless, the strength and direction of the magnetic field can be altered by adjusting the current value and direction. Here, we have a variety of electromagnet types, such as solenoid and torrid, which are used in speakers and conveyor belts. A soft iron core is what makes up a solenoid. Two thousand coils of gauge 22 copper wire are used to wrap it. Because of its extreme retentivity and greater vulnerability, the soft iron core is chosen. This iron core has a permeability of 1.2 mH/m. The copper wire's number of turns is determined by taking the electromagnet's force output into account. The copper wire's current capacity is taken into account when choosing the gauge. This magnetic arrangement is positioned where the cylinder head would be.

2. Relay: An electrically powered switch is called a relay. A magnetic field produced by current passing through the relay's coil draws a lever, changing the contacts. Relays have two switch positions since the coil current can be turned on or off, and the majority of them have double throw (changeover) switch contacts. Relays enable the switching of two circuits, one of which can be totally independent of the other. Relays, for instance, can be used in low voltage battery circuits to switch 230V AC mains circuits. The relay's magnetic and mechanical link between the two circuits is the only internal electrical connection. Here we will be implementing a solid-state relay since it could carry current value up to 10 amps.

3. Battery Unit: We use a 36V DC battery to supply power to the whole system. Lithium-ion batteries can be used as they can have efficiencies of around 99%.

4. Proximity Sensor: Proximity sensor that allows it to identify items in the vicinity without coming into contact with them. It differs from more conventional sensors like pressure switches or touch buttons because of this. Different types of proximity sensors use different techniques to detect items in their immediate vicinity. For our project we are using two proximity sensor which are inductive proximity sensor and Infrared proximity sensors for sensing piston movement from Bottom Dead Centre to Top Dead Centre and Top Dead Centre to Bottom Dead Centre respectively.

C. Magnets

The susceptibility of ferromagnetic materials to an external magnetic field is substantial and positive. Magnets greatly appeal to them, and they can become magnetized for life. The existence of magnetic domains gives them their strong magnetic characteristics.

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The magnetic material field for the component as a whole is zero and domains are arranged arbitrarily when ferromagnetic material is not magnetized. Two excellent examples are iron and nickel. The most prevalent kind of magnets that we are familiar with and use on a daily basis are permanent magnets. For instance, the magnets on our fridges. These magnetic items are permanent in the sense that they hold onto some degree of magnetism once they have been magnetized. Ferromagnetic materials are typically used to create permanent magnets. This kind of material is made up of molecules and atoms that are arranged to reinforce one another and have their own magnetic fields. Depending on their characteristics, magnets can be classified into several categories. Among the most renowned are:

- Neodymium Iron Boron (NdFeB or NIB)
- Alnico
- Samarium Cobalt (SmCo)
- Ceramic or Ferrite

Neodymium iron boron magnets, also known as Nd2Fe14B magnets, neodymium magnets, neo magnets, Nd-Fe-B magnets, 2:14:1 magnet, were developed in the 1980s. Nd2Fe14B has a tetragonal crystal structure. The heavy rare earth element, dysprosium, is often added to increase intrinsic coercivity and maximum operating temperature. Small amounts of other transition metals, such as Al, Co, Cu, Nb and Ga, can be added to modify the micro structure to improve performance. So, what we have chosen is an N35 grade Neodymium magnet of size specification 36 mm vs 6 mm (radius vs thickness).

Table 1 Working conditions of neodymium magnets

Material	Working Temperature °C
Ceramic	400
NdFeB N	100
NdFeB SH	120
NdFeB H	150

IV. CONSTRUCTION

The electromagnetic engine operates on the fundamental principle of magnetism. A magnet has two poles: a north and a south pole. The class of scientific phenomena known as magnetism includes the forces that magnets exert on one another. The magnetism principle states that when similar poles of a magnet are placed together, they repel one another. When two opposite poles are combined, they attract. This also applies to electromagnets and permanent magnets. The idea is to create a path of magnetic field around a cylindrical path by wounding coils around the cylinder and the permanent magnet is placed inside the cylinder

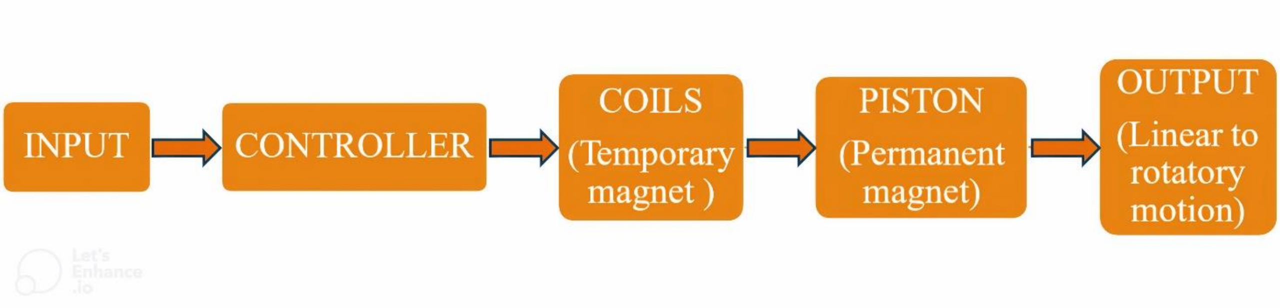

Fig. 2 Hardware Block Diagram

The electromagnetic piston works by using a DC battery to supply coils, which make the coils to act as an electromagnet. Here the due to attraction between electromagnet and permanent magnet the magnetic piston starts the linear motion and then into rotation of the crankshaft. The main energy source is the DC supply that is kept in batteries. The current is conducted to the electromagnet, which transform it into magnetic force. The crankshaft is further rotated by this magnetic force. Through the use of mechanical advantage, the crankshaft will increase the energy. This energy can be used to drive cars or a shaft that turns a generator.

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Fig.3 Hardware model

The electronic controller circuit is composed of several components including a coil, four solid state relays, an inductive proximity sensor, InfraRed proximity sensor, and an accelerator. The circuit is controlled by an ESP 32 microcontroller that receives input from the proximity sensors and accelerator. These values are crucial in determining the triggering of the relay circuit. The relay circuit's primary function is to control the direction of the current flow.

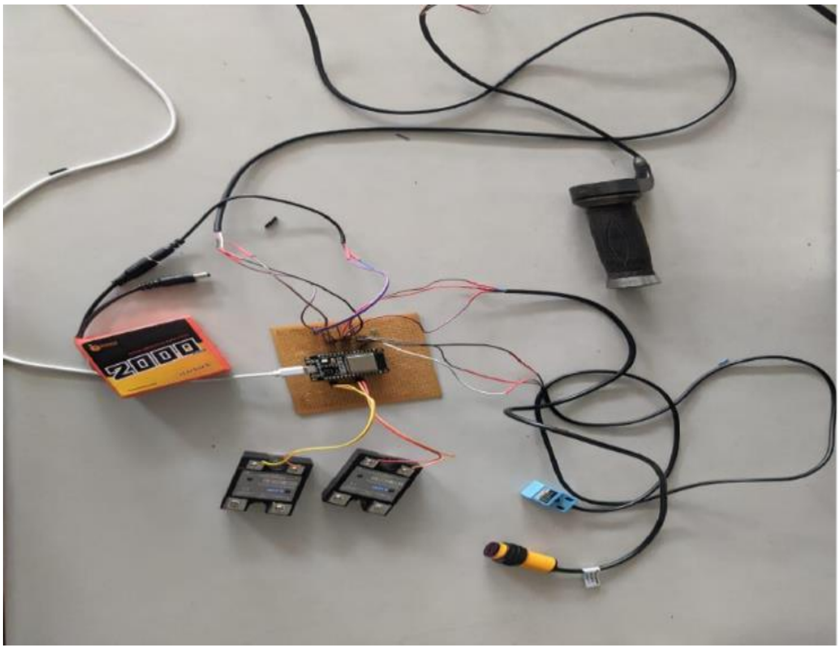

Fig.4 Controller circuit

When the piston is at the Bottom Dead Centre (BDC), the IR proximity sensor value is higher than the threshold value, so the first two solid state relays triggers and the current flows from bottom position of coil to top position which in turns drives the magnetized piston to top position of cylinder. However, as soon as the piston reaches the TDC, the IR proximity value drops and inductive proximity value becomes high triggering the next two solid state relays which in turn, reverses the current flow through the coil.

In addition to the proximity sensor, the accelerator plays a crucial role in regulating the relay circuit's speed. The accelerator determines the time delay before triggering, which, in turn, dictates the relay circuit's switching speed. This switching speed, in turn, determines the speed at which the piston moves, making it an integral part of the circuit's overall functionality.

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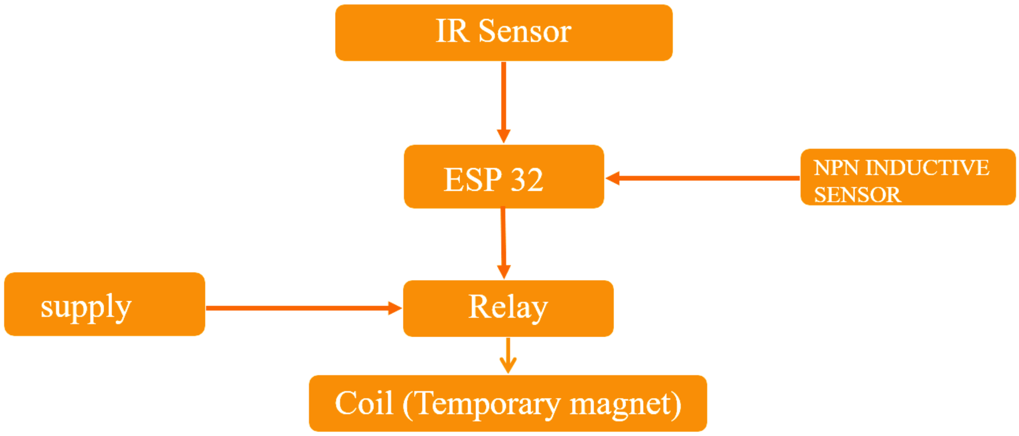

Fig.5 Circuitry block diagram.

V. DESIGN SPECIFICATIONS

Input voltage =150V

Input current = 7 A

Input Power = Voltage × Current = 150 × 7 = 1,050 Watts.

Force exerted by electromagnet on piston, $F1 = \frac{N^2 * I^2 * K * A}{2G^2}$

Where, N = number of turns = 2000

I = Current flowing through coil = 7 A

K = Permeability of free space = $4\pi \times 10^{-7}$

A = Cross-sectional area of the electromagnet=0.0175m

G = Least distance between electromagnet and permanent magnet = 0.05 m

Force F1 = 861.616N

Force exerted by permanent magnet Force F2 = $\frac{B^2 A}{2\mu_0}$

B = Flux density (T)

A = Cross-sectional area of magnet =0.0125 m

μ_0 = Permeability of free space = $4\pi \times 10^{-7}$

Br = Remanence field = 1.21 T

z = distance from a pole face = 0.005 m

D = thickness of magnet = 0.01 m

r_1 = radius of the magnet = 0.0125 m

B= 0.254 T

F2=12.67N

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Total force F = F 1 + F 2,

F = 874.286N

Torque T = F × r_2

Where F = total force on the piston

r_2= crank radius = 0.01m

Torque, T =8.74 N-m

H(heat generated)=$I^2 * R * t$

I=7A

R(resistance)= 18.533 ohm

t(time)=600sec

H=5,44,870J

H =286.91 Celsius Heat Unit

VI. CONCLUSION

Compared to an internal combustion engine, the electromagnetic engine offers a number of benefits. The fact that it is environmentally friendly is the most significant advantage. It doesn't pollute, destroy natural resources, or need the consumption of fossil fuels. The fact that there is no internal heat creation is another point. Even while the electromagnet heats up during continuous operation, it does so at far lower temperatures than internal combustion engines. The conversion kit is relatively easy to install and will not require any major modifications to the existing engine. Thinking forward in years there is chance of banning gasoline engines that may result in mass increase in unusable engines, in that situation a much more calibrated electromagnetic conversion kit can be introduced make those engines re-usable ones. However, the proposed system has several drawbacks like on long-term use the strength of permanent magnet decreases. The torque generated by the engine is not enough to pull a large load so further research and calibration is needed. A cooling system is also needed to be integrated with the system as heat generated by the coil is high. Thus, the project could bring a significant impact towards development of sustainable and environment friendly technologies

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REFERENCES

[1]. Y. Xu, D. Zhao, Y. Wang and M. Ai., "Electromagnetic Characteristics of Permanent Magnet Linear Generator (PMLG) Applied to Free-Piston Engine (FPE)", *in IEEE Access*, vol. 7, pp. 48013- 48023, 2019.
[2]. Piyush Hota, Mahima Rathore, Danish Shaikh, "Magnetic Repulsion Piston Engine", *International Journal of Science and Research (IJSR),* volume 4 Issue 12, December 2015.
[3]. Praful randive sir, Nilesh C. Dukre, Akshay A. Musmade, Rahul B. Gaikwad, "Electromagnetic Engine", *International Journal of Research in Engineering and Science (IJRES),* volume 9 Issue 6, 2021, PP. 10 13.
[4]. P. A. Passeraub, P A. Besse, C. de Raad, O. Dezuari, F. Quinet and R. S. Popovic., "Coin recognition using an inductive proximity sensor microsystem", *Proceedings of International Solid-State Sensors and Actuators Conference (Transducers '97),* Chicago, IL, USA, 1997, pp. 389-392 vol.1.