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A Review on Electromagnetic Piston

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ABSTRACT

The main objective of this project to design and construct an electrically operated engine i.e. Electromagnetic engine. this engine is totally different from ordinary IC engine, because of the inventory advancement in operating principals. We have changed the operating principle of IC engine by using the electromagnetic effect instead of combustion of fossil fuels. This engine works on the principle of magnetic repulsion between two magnets. This electromagnetic engine consists of two magnets, one of them is an Electromagnet and other one is a Permanent Magnet. Permanent Magnet acts as piston and Electromagnet is located at the top of the cylinder instead of spark plug and valve arrangement in IC Engines. In this way this engine does not contain any spark plug and fuel injection system. The Electromagnet is energized by a battery source of suitable voltage and when the electromagnet attract the piston, spring get compressed and it will repel the permanent magnet which is attached to the piston head. i.e. piston from TDC to BDC, which will result in the rotary motion of crank shaft. When the piston is at BDC the supply of Electromagnet is discontinued, the permanent magnet which was repelled to BDC will come back to its initial position i.e. TDC. This procedure completes one revolution of crank shaft i.e. our output work. A copper winding is also wound to the cylinder block to get additional power to the piston to reciprocate. This winding is connected to a battery to create a magnetic field inside the cylinder and reciprocate permanent magnet piston on basis of repulsion forces created by winding. The total power supplied by battery will be just to fulfil the copper losses of winding and power required to magnetize the windings.

Keywords: Permanent Magnet, Piston, Relay, Spring

I. INTRODUCTION

With diminishing fossil fuel resources and unabated increase in energy costs and environmental concerns, engines using alternate energy sources such as bio-fuel, solar power, wind power, electric power, stored power, etc. are being developed around the world. However, such engines have many limitations.

Production of bio-fuel takes enormous resources and they still pollute the environment.

They do not meet the ever increasing energy demand as well. Similarly, the solar power is not efficient. Added to all, the initial capital and subsequent maintenance costs for machines that use alternate energy sources are very high. Hence, in the absence of a viable alternative, until now, switching to new technology by changing from traditional Internal Combustion engines has been a challenge. Magnetism is the basic principle of working for an electromagnetic engine. The general property of magnet i.e. attraction and repulsion forces is converted into mechanical work. A magnet has two poles. A north pole and a south pole. When like poles are brought near each other they repel and attract when like poles are brought together. This principle is being used in the electromagnetic engine. In this engine, the cylinder head is an electromagnet and a permanent magnet is attached to the piston head When the electromagnet is charged, it attracts or repels the magnet, thus pushing then piston downwards or upwards thereby rotating the crankshaft This is how power is generated in the electromagnetic engine. It utilizes only repulsive force that allows the field to dissipate completely, and have no restrictive effects on the rising piston. Before submitting your final paper, check that the format The electromagnetic engine should ideally perform exactly the same as the internal

combustion engine. The power of the engine is controlled by the strength of the field and the strength of the field is controlled by the amount of windings and the current that is being passed through it. If the current is increased the power generated by the engine also increases accordingly. The current that is used to charge the electromagnet is taken from a DC source like a lead acid battery.

The main advantages of electromagnetic engine are that it is pollution free. Also it is easy to design an electromagnetic engine because there are no complicated parts. Since the engine doesn't have combustion, valves, water cooling system, fuel pump, fuel lines, air and fuel filters and inlet and exhaust manifolds etc. can be eliminated from the engine. The main challenge faced in designing an electromagnetic engine is that it has to be as efficient as an internal combustion engine.[1]

II. WORKING PRINCIPLE

The working of the electromagnetic engine is based on the principle of magnetism. A magnet has two poles a north pole and a south pole. Magnetism is a class of physical phenomenon that includes forces exerted by magnets on other magnets. By principle of magnetism, when like poles of a magnet is brought together they repel away from each other. When unlike poles are brought near each other they attract. This is same for the case of an electromagnet and a permanent magnet too. So the idea is to modify the piston head and cylinder head into magnets so that force can be generated between them. This working of the electromagnetic engine is based on attraction & repulsive force of the magnet. The engine greatly resembles the working of a two-stroke engine. To start, let us begin from the situation, when piston is located in the lower position. The coil is connected through the battery, the copper coil is energized to produced the magnetic field the piston in side of the large power Neodymium Iron Boron magnets, the piston moved upper and lower the fly wheel connected through the piston link the copper coil energized the piston move upward and copper coil is de-energized the piston move to downward. With the help of relay and control unit. The continuous process through piston is move to (up and down) with also rotated the fly wheel.[2]

A. SELECTION OF PERMANENT MAGNET

These are the most common type of magnets that we know and interact with in our daily lives. E.g.; The magnets on our refrigerators. These magnets are permanent in the sense that once they have been magnetized they retain a certain degree of magnetism. Permanent magnets are generally made of ferromagnetic material. Such material consists of atoms and molecules that each have a magnetic field and are positioned to reinforce each other. There are various types of magnets depending on their properties. Some of the most well known are
listed below.

Permanent Magnets can be classified into four types based on their composition:
1. Neodymium Iron Boron (NdFeB or NIB)
2. Samarium Cobalt (SmCo)
3. Alnico
4. Ceramic or Ferrite

1. Neodymium Iron Boron (NdFeB or NIB)

Neodymium iron boron magnets, also known as $Nd_2Fe_{14}B$ magnets, neodymium magnets, neo magnets, Nd-Fe-B magnets, $RE_2TM_{14}B$ magnets, or simply 2:14:1 magnets, were developed in the 1980s. $Nd_2Fe_{14}B$ 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/or Ga, can be added to modify the microstructure to improve performance.[3]

Key Features of Sintered NdFeB Magnets Include:

- Highest room temperature maximum energy product, $(BH)_{max}$, up to 52 MGOe
- Relatively less expensive
- Wide range of choices for a variety of applications

B. **Samarium Cobalt (SmCo)**

Permanent Samarium Cobalt magnets (SmCo) are composed of samarium, cobalt and iron. These rare earth magnets are extremely strong for their small size, metallic in appearance and found in simple shapes such as rings, blocks and discs.[4]

Attributes of Samarium Cobalt

- High resistance to demagnetization
- High energy (magnetic strength is strong for its size)

- Good temperature stability
- Expensive material (cobalt is market price sensitive)

MATERIAL	MAXIMUM WORKING TEMPERATURE	
	°C	°F
Ceramic	400	752
Alnico	540	1004
Smco 1, 5	260	500
SmCo 2, 17	350	662
NdFeB N	80	176
NdFeB M	100	212
NdFeB H	120	248
NdFeB SH	150	302
NdFeB UH	180	356
NdFeB EH	200	392

III. CONSTRUCTION OF MAGNETIC ENGINE

The constructions of Magnetic engine mainly consist of components such as:

1. Neodymium magnet.
2. Acceleration unit.
3. Single cylinder engine.
4. Crankshaft.
5. Connecting rod.
6. Magnetized piston.
7. Flywheel.
8. Clamp.
9. Aluminum liner.

Some of the important parts used in Magnetic piston engine are as follows:

A. **Magnetic Piston**

Magnetic Piston uses free energy derived from the renewable resource of magnetism and the Earth's energy field. It does not generate any pollution, so it will help the environment. No exotic materials or alloys are required for piston. Piston requires neodymium magnets.[5]

B. **Cylinder**

Electromagnetic engine uses only magnets for its operation. The cylinder must take care of unwanted magnetic field and other losses further cylinder material Itself should not get attracted to the magnet and resist the movement of the piston. To take care of above issues, the cylinder must be only made up of non-magnetic materials such as stainless steel, titanium or similar materials of high resistivity and low electrical conductivity. The cylinder of an electromagnetic engine is a simple rectangular block with a blind hole in it. The temperature within the electromagnetic engine cylinder is very low and so no fins are needed for heat transfer. This makes the cylinder easily manufacturable. Also the cylinder is made of aluminum, a non-magnetic material which limits the magnetic field within the boundaries of cylinder periphery. Usage of aluminium material makes the engine lighter unlike the cast-iron cylinder used in internal combustion engine.[6]

C. **Power Generation System**

It is used to charge the battery by generating the power from the engine. PGS contains a generator to covert mechanical energy in to electrical energy. A dynamo is an electrical generator that produces direct current with the use of a commutator. A commutator is the moving part of a rotary electrical switch in certain types of electrical generators. With a commutator, a dynamo becomes an alternator, which is a synchronous singly fed generator. Alternators produce alternating current with a frequency that is based on the rotational speed of the rotor and the number of magnetic poles.[5]

D. **Rechargeable Battery**

Where high values of load current are necessary, the lead-acid cell is the type most commonly used. The electrolyte is a dilute solution of sulfuric acid (H_2 SO_4). In the application of battery power to start the engine in an auto mobile, for example, the load current to the starter motor is typically 200 to 400A One cell has a nominal output of 2.1V, but lead-acid cells are often used in a series combination of three for a 6-V battery and six for a 12-V battery.[6]

E. **Relay**

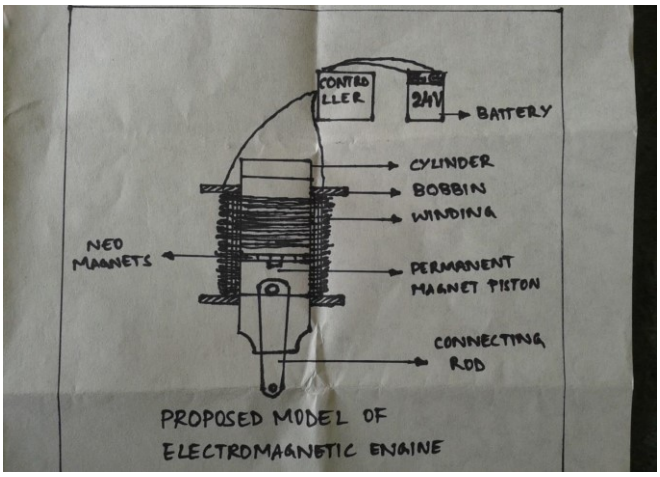
A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so

relays have two switch positions and most have double throw (changeover) switch contacts. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.[6]

F. **Timer 555IC**

The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide up to four timing circuits in one package. Introduced in 1972 by Signetics, the 555 is still in widespread use, thanks to its ease of use, low price, and good stability.[6]

Proposed model of Electromagnetic Engine



IV. ELECTROMAGNETS

An electromagnetic force is one of the four fundamental interactions of nature. Electromagnetism is the physical interaction between electrically charged particles. As proposed by Sir J C Maxwell, there are majorly four electromagnetic interactions present. First, the force of attraction and repulsion between electric charges is inversely proportional to the square of distance between them. Second, magnetic poles always come in pairs, as electric charges do. Third, current flowing in a conductor produces a magnetic field around it. Lastly a travelling electric field will produce a magnetic field, and vice-versa. An electromagnet is a type of magnet which possesses the ability to magnetize and demagnetize as and when required. This control is established by an electric current. When current flows, magnetism is expressed, and it vanishes when there is no flow of current. When a wire is closely wound around a cylindrical object, the side faces of the core exert certain poles when current is passed. The reversal of direction of current, changes the magnetic poles across the iron core. When electric current passes around the core, there is and energy generation called magnetic flux. This magnetic flux is responsible for exerting the magnetic force.[7]

V. DESIGN AND CALCULATION

Input voltage = 36 V
Input current = 1 A
Input Power = Voltage × Current = 36 × 1 = 36W
Max. Force exerted by electromagnet on piston
F1 = (N2I2KA)/2G2

Where,
N = number of turns = 1000
I = Current flowing through coil = 1 A
K = Permeability of free space = 4π×10-7
A = Cross-sectional area of electromagnet (radius r = 0.0175 m)
G = Least distance between electromagnet and permanent magnet = 0.005 m
On substitution, we get Max. Force
F1 =24.18 N
Force exerted by permanent magnet Force
F2 = (B2A)/2μ0
Where,
B = Flux density (T)
A = Cross-sectional area of magnet (radius r = 0.0125 m) μ0= Permeability of free space = 4π×10-7
Now, flux density
B = Br/2 × [(D + z)/(R2 + (D + z)2)0.5 – z/(R2 + z2)0.5]

Where,
Br = Remanence field = 1.21 T
z = distance from a pole face = 0.005 m
D = thickness of magnet = 0.012 m
R = semi-diameter of the magnet = 0.0125 m
On substitution we get flux density,
B = 0.2547 T
Now substituting B in the equation of force,
F2 = 12.67 N
Since, force F1 and F2 are repulsive,
Total force F = F1 + F2 F = 36.85 N
Torque T = F × r
Where,

F = total force on piston
r = crank radius = 0.01m
Torque T = 0.3685 N-m
Mass of Fly wheel $\omega = (2\pi N)/60$,
Where,
N = speed = 200rpm
Therefore $\omega = 20.94$ rad/s
Energy stored on flywheel
$E = T \times \theta$
Where,
T = torque θ = Angle of rotation = $180^0 = \pi$ radians
On substitution we get energy stored
E = 1.157 J
Also $E = 0.5 \times I \times \omega 2$
Where,
I = moment of inertia of flywheel
ω = angular velocity on substitution we get moment of inertia,
$I = 5.277 \times 10\text{-}7$ Kg-m2
Moment of inertia, $I = 0.5 \times m \times r2$
Where,
m = mass of fly wheel
r = radius of fly wheel = 0.07 m
On substitution, We get m = 2.154 Kg
Output power
$P = (2\pi NT)/60$
Where,
N = speed = 200 rpm
T = Torque = 0.3685 N-m
On substitution,
we get Output power
P = 7.718 W
Efficiency = (Output/Input) × 100
= (7.718/36) × 100
Therefore,
Efficiency = 21.44 %

Engine Efficiency

The Electromagnetic Engine is efficient in converting energy from Electromagnetic Energy to Mechanical Energy by using Crank shaft. The Combustion Engine uses crankshaft, but very inefficiently. The Electromagnetic Engine turns the crankshaft more efficiently than the Combustion Engine, requires less strokes and energy to produce more horse power than the Combustion Engine.

VI. APPLICATIONS

- Two wheeler Application.
- Automatic guided vehicle.
- Pump applications.
- Power generating applications.

VII. ADVANTAGES

- Reducing pollution from one source, as opposed to the millions of vehicles on the road.
- Transportation of the fuel would not be required due to drawing power off the electrical grid. This presents significant cost benefits. Pollution created during fuel transportation would be eliminated.
- There is no need to build a cooling system, fuel tank, Ignition Systems or silencers.
- The mechanical design of the engine is simple
- Low manufacture and maintenance costs as well as easy maintenance.
- The price of fueling magnetic powered engine will be significantly cheaper than current fuel.
- No pollution is obtained.
- Consumption of fossil fuel is reduced.
- Initial crank is enough to start the engine.
- Life time of the magnet is high, so it can run for a long period
- No combusting takes place inside the engine. which reduce the evaluation of heat and toxic gases from the engine
- Reduces global warming.
- Green environment is established.

VIII. DISADVANTAGES

- Recharge Points.
- Electricity isn't Free.
- Short Driving Range and Speed.
- Longer Recharge Time.
- Normally 2 Seaters.
- Battery Replacement.
- Not Suitable for Cities Facing Shortage of Power.

IX. RESULTS

The prototype of an electromagnetic engine which works on the principle of magnetism was successfully designed and fabricated. Experimental analysis was successfully performed on the prototype. The results obtained from the experiment are as follows.

- Prototype of an engine which works on the principle of magnetism was successfully manufactured.
- It uses electricity as its input. No fuel is consumed, which was the primary goal.
- The prototype creates no pollution and is eco-friendly.
- The prototype is a two stroke engine.
- Only the repulsive force between the magnet and electromagnet is used for power generation.
- Acceleration is done by controlling the timer which controls the relay.
- Maximum efficiency obtained was 21.22% at 229 rpm for an input current of 1.2A.

  Maximum output power obtained was 20.7W at 249 rpm for an input current of 1.7 A

X. CONCLUTION

In this way an electromagnetic engine has designed. It is different from motor, because the working principle is totally different as well as the power consumption is also very less. The only power consumed is the power consumed by electromagnet. Electromagnet used here is to repel the permanent magnet. There is no extra power consumed by electromagnet to repel the permanent magnet. Movement of magnet doesn't induce back electromotive force in windings of electromagnet. And hence nothing happens similar to electric motor here. Power to be produced at shaft of the engine is much more than the power to be consumed by electromagnet to repel permanent magnet.

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