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Magnetic Piston Operated Engine

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Abstract: In the recent science and technology there is an increase in use of fossil fuels. Recently scientists are searching for an alternative fuels. This project is an answer to replace fossil fuel and reduce pollution by providing main power sources for the automobile engines. This project is to describe the construction and design of a magnetic piston engine, which operate with the help of electromagnetic force. This mechanism is completely different from a normal IC engine mechanism. It works with the principle electromagnetic effect and attraction of magnetic force instead of using fossil fuels. It consists of, two permanent magnet and two electromagnets. Electromagnets are mounted on the cylinder head and the permanent magnets are mounted on the piston head. Here, the use of spark plug and valves are eliminated. Electromagnet contains copper windings. These electromagnets are work on the basis of current supplied to them. The current is supplied from a battery with a required voltage. The piston contains permanent magnet which moves from TDC to BDC and vice versa which will result in converting reciprocating into rotary motion.

Keywords: Solenoid, Reciprocating Engine, Crank Shaft, Electromagnet, Mechanism, Permanent Magnet.

I INTRODUCTION

With reduced fossil fuel resources and increase in energy costs and environmental concerns, engines use 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 disadvantages. Production of bio-fuel takes vast resources and they still pollute the environment. Similarly, the solar power is not efficient. Added to all, the initial capital and subsequent maintenance costs for machines that use alternative energy sources are very high. Hence, in the absence of a viable alternative, as of now, switching to new technology by changing from traditional Internal Combustion engines has been a great challenge. Magnetism is the basic principle of working for an electromagnetic engine. The general property of magnet i.e. repulsion and attraction forces is converted into mechanical work. A magnet has two poles. A north pole and a south pole. When two like poles are brought together they repel each other and when unlike poles are brought together they attract. This principle is being used in the electromagnetic engine.
In this engine, the cylinder head is an electromagnet and the piston head is attached with a permanent magnet. When the electromagnet is charged, it attracts or repels the magnet, in this process it pushes the piston downwards or upwards wherein it rotates 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 resistive effects on the rising piston. 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 merits of electromagnetic engine are that it is pollution free. 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 and so many other parts that are complicated in an IC engine can be disregarded while constructing an Electromagnetic engine. The main challenge faced in designing an electromagnetic engine is that it has to be as efficient as an internal combustion engine.

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. Here the main intention 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

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lower position that is the BDC, the coil is connected through the battery, the copper coil is energized to produce the magnetic field. The piston of the large power Neodymium Iron Boron magnets gets attracted by the electromagnet hence moving the piston from BDC to TDC and hence rotate the fly wheel connected to crankshaft link. While one piston move from BDC to TDC the electromagnet gets de-energized and other electromagnet gets energized and hence resulting the flywheel in completion of full stroke.

III DESIGN

Input voltage = 22.2 V
Input current = 1 A
Input Power = Voltage × Current = 22.2× 1 = 22.2W
Max. Force exerted by electromagnet on piston
$F1 = (N^2I^2KA)/2G^2$ [1]
Where,
N = number of turns = 1000
I = Current flowing through coil = 1 A
K = Permeability of free space = $4\pi \times 10\text{-}7$
A = Cross-sectional area of electromagnet (radius r = 0.020 m)
G = Least distance between electromagnet and permanent magnet = 0.005 m
On substitution,
We get Max. Force F1 = 11.36 N
Force exerted by permanent magnet Force
$F2 = (B^2A)/2\mu 0$ [2]
Where,
B = Flux density (T)
A = Cross-sectional area of magnet (radius r = 0.0125 m)
$\mu 0$= Permeability of free space = $4\pi \times 10\text{-}7$
Now flux density
$B = Br/2 \times [(D + Z)/(R^2+(D + Z)^2)^{0.5} – z/(R^2+Z^2)^{0.5}]$ [3]
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 = 0.01 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 F0 = F1 + F2 F = 19.22 N
Torque T = F × r
Where,
F = total force on piston
r = crank radius = 0.02m
Torque T = 0.3844 N-m
Mass of Fly wheel $\omega = (2\pi N)/60$,
Where N = speed = 150rpm
Therefore ω = 20.94 rad/s
Energy stored on flywheel $E = T \times \theta$
Where,
T = torque
θ = Angle of rotation = 180o = π radians
On substitution we get energy stored E = 1.207 J
Output power $P = (2\pi NT)/60$
Where,
N = speed = 150 rpm
T = Torque = 0.3844 N-m
On substitution,
We get Output power P = 6.038 W

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Efficiency = (Output/Input) × 100 = (6.038/22.2) × 100
Therefore, Efficiency = 27.19 %

IVCOMPONENT DESIGN

A. CYLINDER

Electromagnetic engine uses only magnets for its operation. The cylinder prevents unwanted magnetic field and other losses. Further cylinder material itself should not have the properties of attraction and repulsion hence it should not disturb the movement of the piston. As a solution to the above issues, the cylinder must be only made up of non-magnetic materials such as stainless steel, fiber, titanium or similar materials of high resistivity and low electrical conductivity. The cylinder of an electromagnetic engine is a simple cylindrical 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 a product to manufacture. Also the cylinder is made of aluminium, 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.

B. PISTON

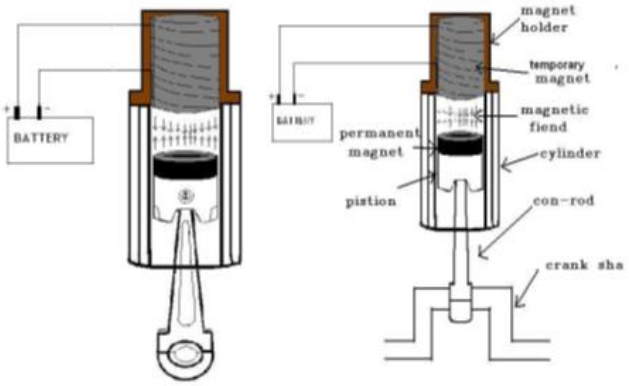

Fig. 1 Diagram of Magnetic Piston Operated Engine

The hollow piston casing is made up of non-magnetic stainless steel, titanium or similar materials which are of high resistivity and low electrical conductivity. Alternatively, piston casing can also be made up of non-metallic, thermal resistant materials can be made by integrating both non-magnetic and non-metallic materials. One end of the hollow case is fitted with a powerful permanent magnet made of neodymiumiron-boron (NdFeB), samarium-cobalt (SmCo) or similar high field strength magnetic materials. The permanent magnet acts as the core of the piston. The flat surface (which is also the pole of the magnet) of the piston that is nearer to the pole of the electromagnet is called the magnetic head of the piston or piston head. The flat surface of the piston head may be completely exposed or it may be covered by a thin layer of non-magnetic material of sufficient thickness. The other end of the piston case connects to the piston rod which in turn connects to the crankshaft. The crankshaft and the piston rod convert the linear reciprocating movement of the piston to the circular movement.

When rotated one-half revolution the stress in the fibres originally above the neutral axis of the specimen are reversed from compression to tension for equal intensity.Upon completing the revolution, the stresses are again reversed, so that during one complete revolution the test specimen passes through a complete cycle flexural stress.

C. CONNECTING ROD

In a reciprocating engine, the connecting rod is used to connect the piston to the crankshaft. It converts the linear motion or reciprocating motion of the piston to the circular motion of the crankshaft. The connecting rod used in this engine is M10 bolt. The material of the connecting rod is cast iron. As the magnetic fields are contained inside the cylinder, the connecting rod will not be affected much. The connecting rod is same as that of an Internal Combustion engine.

D. FLYWHEEL

Flywheel is made up of mild steel and it is used to convert reciprocating energy into rotational energy. It regulates the engine's rotation, making it to operate at a steady speed. Flywheels have a significant moment of inertia and which resist changes it rotational speed. The amount of energy stored in a flywheel is proportional to the square of its

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rotational speed. Energy is transferred to the flywheel by applying torque to it. It is used to store the rotational kinetic energy.

E. ELECTROMAGNET

An electromagnetic coil is formed when an insulated solid copper wire is wound around a core or form to create an inductor or electromagnet. When electricity is passed through a coil, it generates a magnetic field. One loop of wire is referred to as a turn or a winding, and a coil consists of one or more turns. For use in an electronic circuit, electrical connection terminals called taps are often connected to a coil. Thrs= Coils are often coated with varnish or wrapped with insulating tape to provide additional insulation and secure them in place. A completed coil assembly with one or more set of coils and taps is often called the windings.

F. 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 seriescombination of three for a 6-V battery and six for a 12-V battery.

V RESULTS AND CONCLUSION

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 attractive force between the magnet and electromagnet is used for power generation.
- Acceleration is done by controlling the timer which controls the relay
- The efficiency and power output of the engine was less than what was expected. The reason for less power and efficiency are
- The windings of the electromagnet are not perfect. The windings are not machine wound. It was wound with hands. So windings are not tight and there is air gap. The field generated will not be as strong as expected
- The fabrication work and the design are not perfect. There might be some misalignments and it might cause a drop in output.

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