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A Study on Electromagnet Operated Piston Engine

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ABSTRACT

There is a growing demand for the need of alternative fuels for transportation. Increasing the efficiency and reducing the exhaust gases in engines have been dominant in the fields of research. The exhaust gases contain numerous pollutants that are extremely harmful though in chronic conditions. Hence, Electromagnetic engines were created that uses the combined power of an electromagnet as well as a permanent magnet. While these engines have already proven their worth as alternative sourced engines, non-polluting and eco-friendly, the current challenge is to make them more efficient, reliable and cost effective.

Introduction

H - strength of the magnetic field in ampere turns / meter
N - number of turns of the coil
I - current flowing through the coil in amps, A
L - length of the coil in meters, m
F - flux density
A - area of piston affected by electromagnet

With the rise in consumption of fossil fuels, there arises a need to switch to alternative sources of fuel, to drive internal combustion (IC) engines. But the challenge is to develop machines which have much higher efficiencies than what is being used today. With this rising need of switching to alternative fuels, and alternative sources of energy, application of magnetic power shows a bright spot in the current scenario. The development of magnetic repulsion piston engine refers to the system where the piston attached with a permanent magnet is being pushed by an electromagnet, and again being attracted. The reciprocating motion of the piston is converted into rotary motion by the connecting rod and crank [1] in a usual manner.

This concept can complement or replace existing internal combustion engines that use fossil fuels. This system is environmentally friendly, and does not pollute the ecosystem and its application tends limitless with working cost being minimal.

Objective

It is evident that electromagnet engines are not able to perform as efficient as a conventional IC engine [2]. Though a number of designs and methodologies have been proposed, none of them is promising for application in an automobile. So the objective of the project is to develop a new design and methodology to obtain maximum efficiency and to test its performance under different load and speed conditions. A new design can be suggested to overcome the problems, in which neodymium magnets and electromagnets can be used to attract and repel a piston with less weight [3]. A permanent magnet with greater force can be used to increase the output torque.

Components Used in the Model

IC Engine

The internal combustion engine is an engine in which the combustion of a fuel occurs with an oxidizer in a combustion chamber. The expansion of the high-temperature and high-pressure gases produced by combustion apply direct force to the piston. Here we replace the spark plugs by electromagnet and a permanent magnet is mounted on the piston. The piston moves to and fro due to attractive and repulsive forces, when the electromagnet is energized [3].

Electromagnet

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 [1]. 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.

$H = (I \times N)/L$ [2].

Permanent magnet

A permanent magnet is a piece of magnetic material that retains its magnetism even after being removed from an external magnetic field. The permanent magnets which have produced the largest magnetic flux with the smallest mass are the rare earth magnets based on samarium and neodymium. So n32 grade magnets [3] can be used.

DC Battery

A 24V DC battery can be used to supply power to the whole system [1]. Lithium ion batteries can also be used as they can have good efficiency. The relation between resistances offered to current flow in various gauges of wires is shown in Fig. 1 below.

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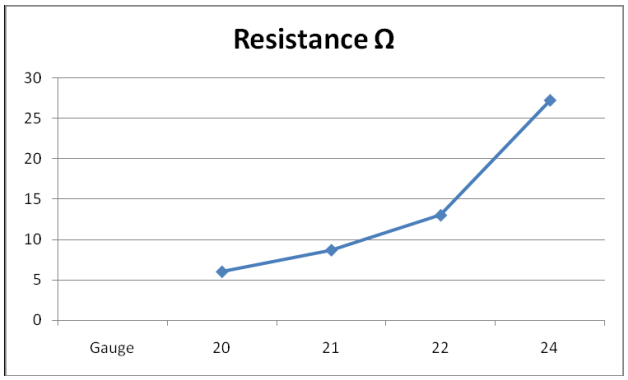

Figure 1. Resistance to current flow [1]

H-bridge inverter

A device that converts dc power into ac power at desired output voltage and frequency is called an inverter. The dc power input is obtained from the dc battery used here. Since half bridge inverters require 3-wire dc supply, we use a single phase full bridge voltage source inverter to convert the dc supply into AC square wave. The output voltage is therefore doubled and the output power is increased by four times [3].

IR Sensors

We chose to use the optical method to sense the position of the piston. These sensors are fast, and can be used without any complicacies. To simplify further we used the emitter and detector separately. At one end was the infrared emitter, and diametrically opposite was the detector located. Whenever there was a break in the path of light, a high signal used to pass from the circuit. One such sensor is shown in Fig. 2.

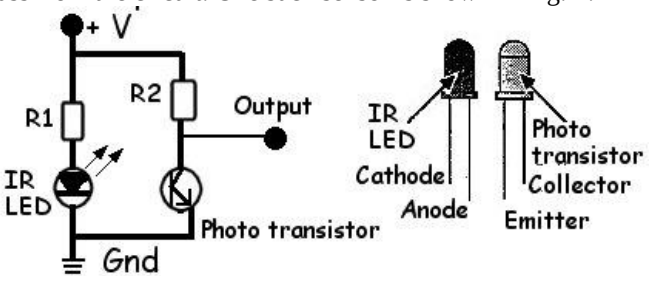

Figure 2. Infrared Emitter Detector pair.

Construction

The cylinder, piston and connecting rod appear similar to the conventional internal combustion engine or it may vary in certain areas. The arrangement, as shown in Fig. 3, completely depends upon the configuration used in designing the electromagnetic engine. It has a permanent magnet, electromagnet, piston, cylinder and connecting rod.

Neodymium is used as the permanent magnet and is mounted on top of the piston. Neodymium is either welded or stuck using super glue to keep it from coming out of the piston, while working. The electromagnet is placed in the position of spark plug. A stack of permanent magnets is mounted on the piston head with its north/south pole always facing the fixed electromagnet. When the electromagnet on top of the cylinder is excited by an ac supply it acquires positive and negative charges for each half of the supply. For instance, the electromagnet will act as a north pole for positive supply and south pole for the other or vice versa

Working Principle

The piston consist of permanent magnet assume that south pole is on up side and it free to slide into the cylinder and electromagnet is placed on this magnet. The phenomenon of electromagnet is that as we apply the charge of current the magnetic flux is produce in it and it also act as magnet.

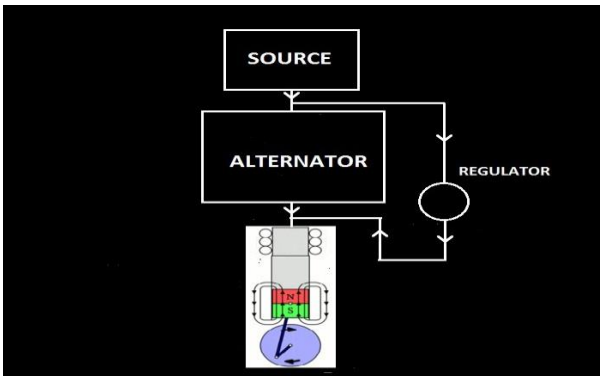

Figure 3. Block diagram of setup

This create its own two poles and we arrange such way that the south pole is face toward the piston as shown in Fig. 4. When the current is introduced into that magnet it gets charge and produces its own pole as we repulsion. The starter is required to rotate this engine assembly initially. The switches are mounted beside of crank shaft and it operates by cam arrangement. As piston move from TDC to BDC its get on and when it travel from BDC to TDC it is in off condition. Lower and higher the speeds of this engine by electronic means i.e. lower or higher the current frequency.

Electromagnet is positioned on the top of the cylinder of engine, and permanent magnet is used as the piston in engine. Piston of the engine is connected to the crank shaft through connecting rod. Connecting rod is connected to the crank shaft by using gudgeon pin. The cam and follower arrangement is used to control the switching of electromagnets. When similar poles of two magnets come in contact with each other they will repeal each other with equal and opposite force. This phenomenon of repulsion is used in this engine to create motion. The Electromagnet which is placed at the top of the cylinder of the engine repels the permanent magnet placed at the place of piston in IC Engine such a way that the magnetic force produced by the electromagnet repels permanent magnet. Piston i.e. Permanent magnet is connected to the crank shaft through connecting rod. This arrangement converts the reciprocating motion of piston into the rotary motion of the crank shaft. This is our useful work arrange it before two same poles are kept in contact it

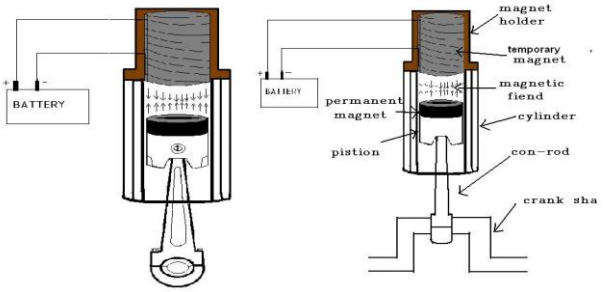

Figure 4. Electromagnetic engine setup

Force between electromagnets

The above methods are inapplicable when most of the magnetic field path is outside the core. For electromagnets (or permanent magnets) with well defined 'poles' where the field lines emerge from the core, the force between two electromagnets can be found using the 'Gilbert model'

Magnetic field required to move the piston (B) $=\mu In$ and

Magnetic force or force of solenoid on the piston

$$Fp = \frac{1}{8\pi} f^2 \times A^2 \times 10^{-7} \text{ N}$$

There are several side effects which become important in large electromagnets and must be provided for in their design [4].

Effect of temperature on magnets

Magnetic materials have a wide range of working temperatures. NdFeB material comes in many different heat tolerances but as the heat tolerance increases the maximum available flux density decreases [2].

Features

This innovative technique allows extraction of energy in a clean way which reduces the emissions due to which pollution is minimized to a large extent. So health disorders arising due to pollution can be eradicated to some extent. The salient feature of this engine is that it does not require fossil fuels to run. Also, it does not need motor for operation. The starting torque of the engine is high [3]. The life of the battery source is increased since the battery is charged simultaneously while the engine is running [4].

The greatest advantage is that these engines need not be specially manufactured, as existing engines can be easily modified to work this way. The weight of the vehicle is reduced, thus improving the efficiency of the vehicle. Fig. 5 shows the behavior of the magnet with temperature.

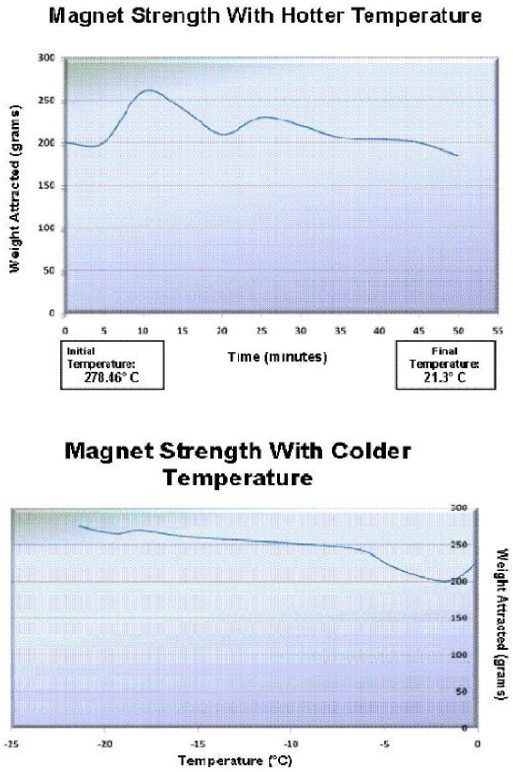

Figure 5. Effect of temperature on magnets [2].

Merits

The demand for fossil fuels keeps on increasing and there will be a time when the world will have to depend on electricity as the only source of fuels. Though electric engines are heavy and require more power, they have lesser efficiency when compared to IC engines. A magnetic engine is a promising alternative to the internal combustion engines due to the following factors.

- There is no hazard to the surroundings because electromagnetic engines cause no atmospheric pollution.
- Serves as a promising alternative to the fossil fuels.
- Better efficiency for operations requiring lesser torque.
- Less maintenance is only required.
- Lighter than an internal combustion engine.
- Lighter than an internal combustion engine

Conclusions

In this paper, there is a probability of a revolutionary engine which need not be separately manufactured, but existing engines can be easily modified to work this way. The proposed engine is a simple and excellent technique to run the vehicle in a highly efficient manner.

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