ORIGINAL RESEARCH PAPER

Engineering

SOLENOID ENGINE

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ABSTRACT

Two of the three books mentioned in the lead-up to this page, "Model Making for Young Physicists" by A.D.Bulman and "The Boy Electrician" by Alfred P. Morgan, each presented a model which could be described as a "solenoid engine". The most obvious difference between them is that one of them (Bulman's) had only one solenoid, while Morgan's had two. The most obvious thing that they had in common is that they both relied on moving contacts.

The main objective of our project to design and construct an electrically operated engine i.e. Electromagnetic Engine. Our engine is totally different from ordinary IC Engine, because of the inventory advancement in operating principles. We have changed the operating principle of IC Engine by using 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 the polarities of electromagnet are set in such a way that it will repel the permanent magnet 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. The total power supplied by battery will be just to fulfill the copper losses of winding and power required to magnetize the windings.

I. OBJECTIVE

1. The main objective is to form a mechanism which work as an IC engine without using any fuel.
2. This system works on the principle of electromagnetism and it is powered by electromagnetic coil.
3. This system is fully emission free i.e. it doesn't produce any harmful gases. And that is our sole purpose.

II. INTRODUCTION

.Like conventional engines this system also has cylinder, piston (without piston rings), connecting rod, crank shaft. There is no inlet & exhaust valve or ports & no spark-plug also. In this system we are using 4 Solenoids. Solenoid behaves like a magnet when electricity supplied to it. These solenoids with iron core works as a piston cylinder arrangement as in IC engines. Magnetism is the basic principle of working for an electromagnetic engine. The general property of magnet i.e. attraction and repulsion forces and that is converted into mechanical work. 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 use only repulsive force that allows the field to dissipate completely, and have no restrictive effects on the rising piston. The electromagnetic engine should ideally perform exactly the same as the internal combustion engine.

This mechanism is entirely different from normal IC engine mechanism. It works with electromagnetic effect and repulsion of magnetic force instead of fossil fuels. It consists of, two permanent magnet and two electro magnet. Here not using spark plug and valve arrangement. Electro magnet contains copper windings. Electro magnets are getting power supply from the battery by suitable voltage. The piston contains permanent magnet moves from TDC to BDC and BDC to TDC which will result, convert reciprocating motion into rotary motion of crank shaft. Power supply from battery to the electro magnets are controlled by micro controller with help of power splitter, timer and relay switch arrangement. We can also control its speed by using an fan regulator. This paper is all about an engine which will work on electric supply. This engine can work on both type of supply AC as well as DC supply.

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.

III. LITERATURE REVIEW

The American scientist Joseph Henry (1797-1878) constructed a small electromagnetic engine, with a reciprocating beam. He

called it as a "philosophical toy", and there was certainly no intention of getting useful work out of it. It was first described in American Journal of Science, 1831, Vol 20 p342. In a British journal Philosophical Magazine in 1838, F Watkins examined Henry's invention in detail and described it as the first cyclic electric motor, ie one that continued working without manual switching or resetting.

Also the paper published in Power and Energy Conference, 2008. PECon 2008. IEEE 2nd International states that, Designing an electric vehicle (EV) using electric motor as its prime mover is very common. However, incorporating the electric motor to the overall EV design is relatively complex. The latest layout design of an EV requires a complex controller to govern the whole system especially the electric motors. Due to this complexity, the authors have developed an alternative electromagnetic prime mover for EV to replace the existing electric motor. This new prime mover is designed based on the solenoid concept and the internal combustion engine (ICE) working mechanisms. In this paper, the authors are introducing a new electromagnetic prime mover known as solenoid powered engine (SPE).

IV. WORKING PRINCIPLE

The electromagnetic piston engine according to the present invention in one aspect comprises a cylinder and a piston, each made of a magnetic material, a cylinder electromagnet having an inner wall of the cylinder magnetisable to a one magnetic pole, and a piston magnetization unit for magnetizing a portion of the piston engage able with the cylinder to a single magnetic pole in a fixed manner, in which the piston is transferred in a one direction by creating a magnetic attraction force between the cylinder and the piston by exciting the cylinder electromagnet; and the piston is then transferred in the opposite direction by creating a magnetic repellent force there between, followed by repeating this series of the actions of alternately creating the magnetic attraction force and the magnetic repellent force to allow the piston to perform a reciprocal movement.

The electromagnetic piston engine according to the present invention in a still further aspect is constructed by arranging a combination of the cylinder with the piston in -the aspects described above as a one assembly, arranging the one assembly in plural numbers and operating the plural assemblies in a parallel way, and converting a reciprocal movement of the piston in each of the plural assemblies into a rotary movement of a single crank shaft by a crank mechanism so that more can be produce for propelling any heavy vehicle.

A common tractive electromagnet is a uniformly-wound solenoid and plunger. The solenoid is a coil of wire, and the plunger is made of a material such as soft iron. Applying a current to the solenoid applies a force to the plunger and may make it move. The plunger stops moving when the forces on it are balanced. For example, the forces are balanced when the plunger is centered in the solenoid.

The maximum uniform pull happens when one end of the plunger is at the middle of the solenoid. An approximation for the force F is

$$F = CAnI/l$$

Where C is proportionality constant, A is the cross-sectional area of the plunger, n is the number of turns in the solenoid, I is the current through the solenoid wire, and l is the length of the solenoid. The maximum pull is increased when a magnetic stop is inserted into the solenoid. The stop becomes a magnet that will attract the plunger, but it adds little to the solenoid pull when the plunger is far away, but dramatically increases the pull when they are close. An approximation for the pull P is

$$P = AnI[(nl/)]$$

Here la is the distance between the end of the stop and the end of the plunger. The additional constant C1 for units of inches, pounds, and amperes with slender solenoids is about 2660. The second term within the bracket represents the same force as the stop-less solenoid above; the first term represents the attraction between the stop and the plunger.
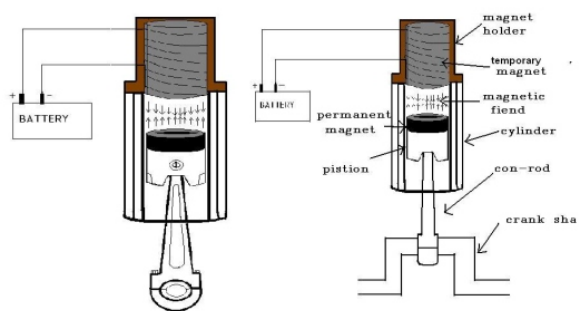
Diagram of Magnetic Piston Operated Engine

V. FORMULA USED

Max. Force exerted by electromagnet on piston

$$F_1 = \frac{N^2 I^2 KA}{2G}$$

where,
N = number of turns = 1000
I = Current flowing through coil = 1 A
K = Permeability of free space = $4\pi \times 10^{-7}$
A = Cross-sectional area of electromagnet (radius r = 0.0175 m)
G = Least distance between electromagnet and permanent magnet = 0.005 m

Force exerted by permanent magnet

$$F_2 = \frac{B^2 A}{2\mu 0}$$

where,
B = Flux density (T)
A = Cross-sectional area of magnet (radius r = 0.0125 m)
μ_0 = Permeability of free space = $4\pi \times 10^{-7}$

Now flux density is given by:

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 = 0.0125m

Torque Calculation
Torque T = F × r
where,
F = total force on piston
r = crank radius = 0.01m

Energy stored in flywheel
E = T × θ
where,
T = torque

θ = Angle of rotation = 180o = π radians

Power Calculation
P $\frac{2\pi NT}{60}$

where,
N = speed = 200 rpm

T = Torque = 0.3685 N-m

VI. RESULT AND DISCUSSION
The results are as follows:
1. We are able to make a working model of electromagnetic engine. This works on principle of electromagnetism.
2. A fully emission free engine mechanism is developed by the arrangement of 4 electromagnetic coil with a designed crankshaft.
3. This engine has less efficiency then conventional IC engines.
4. Its speed can be controlled by a regulator.

This system needs more development for its use in near future. Further improvement is needed for increasing its efficiency and its use ability in daily life.

VII. CONCLUSION
Design and working of magnetic piston engine is different from other engine. The Principle of Operation of Electromagnetic Engine is Different than that of Internal Combustion Engine. The electromagnetic engine has various advantages over the internal combustion engines. The main advantage is, no fuel is being used in the engine. This results in no pollution which is very desirable in the present day situation. As there is no combustion taking place inside the cylinder there is only very little heat generation it is more economic and free from air pollution. Magnet is one of the prime power source used for many application. By the demand of fossil fuels expecting that electro magnet is main alternative fuel and it is very much useful for coming generation. Power to be produced at shaft of the engine is much more than the power to be consumed by electromagnet to repel permanent magnet. Thus electromagnetic engine gives Green energy, as no harmful by-product is emitted in Surrounding Atmosphere. Thus is the future of Automobile Industries.

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