Design and Analysis of Solenoid Engine

Devansh Tiwari [1], Diwakar Maurya [2], Km. Neha Soni [3], Manish Kumar Singh [4] , Amit Kumar Singh [5]
Students[1][2][3][4], Assistant Professor [5]
Department of Mechanical Engineering
United Collage of Engineering & Management, Naini, Prayagraj, India

Abstract

Combustion takes place & produces heat which converts into mechanical energy. We know IC-Engines are used in Automobiles, Aero plane etc. But the incomplete combustion produces some harmful gasses, which is one main cause of air pollution. Modern Science & Technology has been taken many positive steps for emission control. Like, using CNGs & LPGs instead of petrol & diesel. Now technology brings Electrical bikes, scooters & cars. The battery of electrical vehicle can charge easily like mobile. They have less running cost & 100% emission free. But they have very less load carrying capacity & not suitable for long run. So basically we have to prefer Engines for more power & more running capacity. Here I have introduced a mechanism which has more load caring & running capacity than electrical vehicles but make zero emission or pollution

Keywords:- CNG, LPG

1. Introduction

This project is about to design electricity operated engine construction. In this engine there is no use of fuels like diesel and petrol. So this engine is operating on pure electricity coming from a battery source. An electromagnet is positioned on the top of the cylinder, while construction of engine is traditional. And piston is just a permanent magnet (Neodymium magnet). There is no combustion within the cylinder so design of piston and cylinder arrangement is simpler as compared to IC Engine. So the accuracy of dimensions is not a serious matter here. Although this engine can't produces any flue gases which are harmful to the environment, because there is no combustion of fossil fuels in this engine.

2. Literature Survey

Electromagnetic Reciprocating Engine Kala Butler: Business has been looking to end its dependency on Oil. Oil supplies are dwindling, the demand is increasing along with the cost. The Electromagnetic Reciprocating Engine, for which Sekou holds the patent, can replace the Combustion Engine; it does not use any fossil fuels. The Electromagnetic Reciprocating Engine can replace the Combustion Engine in any vehicle, eliminating the fuel cost. The Electromagnetic Reciprocating Engine can replace the Combustion Engine in an engine-generator, creating green renewable electricity. The Electromagnetic

Reciprocating Engine has a low operating cost with an 110,000 hour or 12 year maintenance cycle. The Electromagnetic Reciprocating Engine can end the need for fossil fuels in transportation and electricity production for homes and businesses.

3. Working Process

The working of solenoid engine was based on electromagnetism principle. When current passes through the conductor the magnetic flux will be generated around the conductor this phenomenon is known as electro magnetism. At first when we flick the fly wheel it rotates the crank shaft and a non uniform circular disk, mounted on the crank shaft. During the half the revolution of non uniform circular disk the inductive proximity sensor on's hence the current flows to the solenoid coil trough the relay, and the solenoid coil act as electro magnet due to this effect, piston moves in to the cylinder. While the other half the revolution of the non uniform circular disk the inductive proximity sensor off's hence the current doesn't in to the solenoid coil hence the piston comes out of the solenoid coil and the cycle repeats.

4. Components

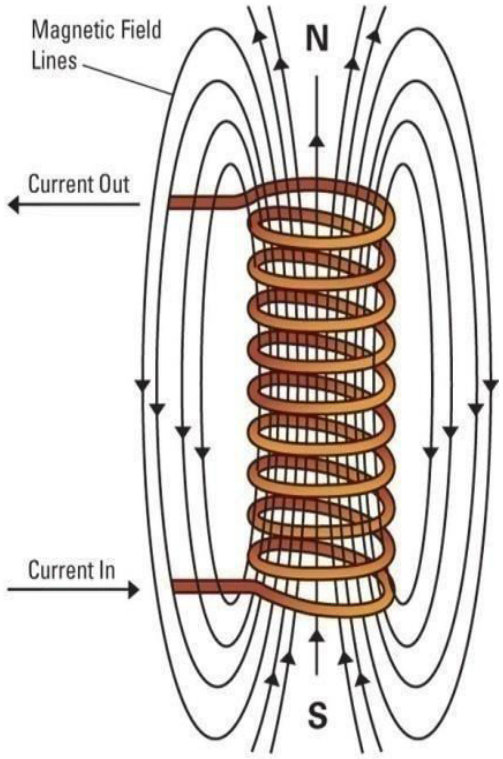
- Electromagnetic solenoid
- Connecting rod
- Proximity sensor
- Relay
- Crank
- PCB
- Bearing
- Transformer

5. Electromagnetic Solenoid

When a current carrying conduct or is wound on a magnetic material (ferrite),it acts as a magnet till the conductor is live. An air core electromagnet that acts as a solenoid is used here. Since it has an air core, the core losses are eliminated.

The electricity magnetizes the electromagnet, and when the current jumps to unsafe levels, the electromagnet is strong enough to pull down a metal lever connected to the switch linkage.

The electromagnet provides the driving force to close the contacts, which are the current carrying part of the contactor. An electromagnet is a temporary magnet formed by winding a coil of wire round a piece of soft iron, and passing an electric current through it.



6. Connecting Rod

A connecting rod is a shaft which connects a piston to a crank or crankshaft in a reciprocating engine. Together with the crank, it forms a simple mechanism that converts reciprocating motion into rotating motion. A connecting rod may also convert rotating motion into reciprocating motion, its original use. Earlier mechanisms, such as the chain, could only impart pulling motion. Being rigid, a connecting rod may transmit either push or pull, allowing the rod to rotate the crank through both halves of a revolution. In a few two-stroke engines the connecting rod is only required to push.

7. Proximity Sensor

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact.

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal.

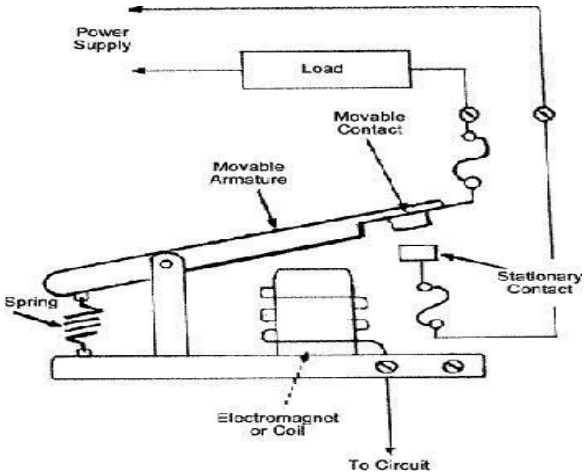
The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive proximity sensor or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target.

The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance. Some know these processes as "thermo sensation".

Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.

8. Relay

A relay is an electrically operated or electromechanical switch composed of an electromagnet, an armature, a spring and a set of electrical contacts. The electromagnetic switch is operated by a small electric current that turns a larger current on or off by either releasing or retracting the armature contact, thereby cutting or completing the circuit.



9. Crank

A crankshaft—related to crank—is a mechanical part able to perform a conversion between reciprocating motion and rotational motion. In a reciprocating engine, it translates reciprocating motion of the piston into rotational motion; whereas in a reciprocating compressor, it converts the rotational motion into reciprocating motion.

In order to do the conversion between two motions, the crankshaft has "crank throws" or "crankpins", additional bearing surfaces whose axis is offset from that of the crank, to which the "big ends" of the connecting rods from each cylinder attach.

It is typically connected to a flywheel to reduce the pulsation characteristic of the four-stroke cycle, and sometimes a torsional or vibrational damper at the opposite end, to reduce the tensional vibrations often caused along the length of the crankshaft by the cylinders farthest from the output end acting on the torsional elasticity of the metal.

10. Bearing

The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks. Bearing is made upon steel material and bearing cap is mild steel.

11. PCB

Stands for "Printed Circuit Board." A **PCB** is a thin board made of fiberglass, composite epoxy, or other laminate material. Conductive pathways are etched or "printed" onto board, connecting different components on the **PCB**, such as transistors, resistors, and integrated circuits.

12. Transformer

A transformer is a passive electrical device that transfers electrical energy from one electrical circuit to another, or multiple circuits. A varying current in any one coil of the transformer produces a varying magnetic flux in the transformer's core, which induces a varying electromotive force across any other coils wound around the same core. Electrical energy can be transferred between separate coils without a metallic (conductive) connection between the two circuits. Faraday's law of induction, discovered in 1831, describes the induced voltage effect in any coil due to a changing magnetic flux encircled by the coil.

13. Analysis

Input :-

Input power = Voltage × Current ;

Voltage = 24 V ;

Current = 1 A ;

Input power = 24 × 1 = 24 W ;

Output :-

Total force on piston, F = F1 + F2 ;

Force exerted by electromagnet, F1 = $(N^2I^2kA)/2(G^2)$;

Number of turns, N = 1000 ;

Current, I = 1 A ;

Permeability of free space, k = 4π×10^-7 ;

Cross sectional Area of Electromagnet, A = $\pi \times r^2$; where, r = 0.015 m ;

Gap between permanent magnet and electromagnet, G = 0.005 m ;

Hence,

F1 = ($(1000)^2 \times (1)^2 \times$ 4π×10^-7)/($2 \times (0.005^2)$) ;

F1 = 24.18 N ;

Now,

$F2 = B^2A/2\mu 0$;

Flux Density, B = 0.25 T ; (Given)

Cross-section Area of Magnet, A = $\pi \times 0.012^2$; where, r = 0.012 m ;

Then,

F2 = $((0.25)^2 \times 4.524 \times 10^{-4})/(2 \times 4\pi \times 10^{-7})$;

F2 = 11.25 N ;

Therefore,

Total force, F = F1+F2 = 24.18+11.25 = 35.43 N ;

Further,

Torque exerted, T = F × r ;

F=35.43N;

Crank radius, r = 0.016 m ;

T = 35.43 × 0.01 ;

T = 0.3543 N ;

Therefore,

The Input Power,

P = 2πNT/60 ;

RPM = 200 ;

Torque, T = 0.3543 N ;

Hence,

P=(2×π×200×0.3543)/60; P =

7.42 Watt ;

Therefore,

Efficiency = Output/ Input ;

Output = 7.42 Watt ;

Input = 24 Watt ;

Efficiency = 7.42/24 ;

= 0.3091 ;

Efficiency of Solenoid Engine = 30.91%

14. Advantages

- It has less running cost than an Engine.
- It does not make pollution (basically air pollution) & can help to check Global warming.
- It takes less amount of charge from battery in every revolution of crank shaft for few fractions of seconds.
- It can produce much more power & running capacity than battery car & bikes.

This cannot produce much power like an IC-Engine but can be use as an equivalent system of an engine & it is acceptable for future.

15. Disadvantages

- It cannot produces power like an engine.
- It can provide less uniform torque at cranks engine
- It is not applicable for multi-cylinder system.

16. Photographic View

17. 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 repulsive 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 on a lathe. So windings are not tight and there is air gap. The field generated will not be as strong as expected.

- The windings are not laminated. It will result in copper losses and hysteresis losses.

- The use of relay limits the flow of current as it offers a resistance. So with less current flow, the field generated by the electromagnet will be less and results in less force.

- The fabrication work and the design are not perfect. There might be some misalignments and it might cause a drop in output.

References

- Nobuaki Takeda, Sadao Imai, Yusuke Horri, Hiroaki Yoshida, Development of High Performance Lithium Ion batteries for hybrid vehicle.
- Leland W. Gifford; "reciprocating electromagnetic engine"; US 5457349 A
- Amarnath Jayaprakash, Balaji, G., Bala Subramanian; "Studies On Electromagnetic Engine"
- DruvaKumar.L1, Jathin. P ;"Future Energy Redefined By Magnetics".
- B. L. Thereja Electrical Technology, Volume II, pp.866 to 886 and Electro Droid software for Magnetic Coil Calculations.
- Sherman S. Blalock, Electro-magnetic reciprocating engine; US 4317058 A
- V. Ganesan; Tata McGraw-Hill Education-Internal Combustion Engines.
- “Design and development of a new electromagnetic prime mover solenoid powered engine preliminary design”, by Syed Zainal Abidin , Kamarul Bahrin ; Department of Electrical Power University Tenaga Nasional Selangor, Malaysia.
- Kiniski Z; "Rotary-to-reciprocating device"; US 3811058A
- David Meeker. Finite Element Method Magnetic Manual.
- National Imports LLC .Permanent magnet design and selection handbook.