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Design and Development of V8 Solenoid Engine

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Abstract - *In an automobile, engine is the main power source and today, majority of the engines are Internal Combustion (IC) Engines which use either Petrol or Diesel as the main fuel source. The combustion of these fuels in the piston releases heat Energy which is converted into mechanical Energy. These fuels release harmful gases after combustion and hence pollute the environment as well as have adverse effects on the living beings.*

Fossil fuels are going to get exhausted in the near future and currently, Electric Cars are the best alternative to the conventional gasoline engine cars. Electricity is a clean source of energy with almost zero emissions. The objective of this project is to design a solenoid engine which works on the principle of Electromagnetism. This concept is used to convert electrical energy into mechanical energy and the power generated is used to drive the car.

Key Words: Solenoid, Electromagnetism, Spark Distributor, Rheostat, V8 Engine.

1. INTRODUCTION

The production and development of electric vehicles is increasing day by day and continuous research is going on in this field to increase the efficiency and to find alternatives to the existing concept. Currently, all the electric cars are driven by one or more electric motors, using the energy stored in rechargeable batteries.

The aim is to design a V8 Solenoid Engine which works on the principle of electro-magnetism. The piston in the conventional IC engine is replaced by the solenoid and it converts electrical energy into mechanical energy. This energy produced is used to power the wheels and run the car. Electric energy is a clean source of energy which replaces the conventional fossil fuels usage and it strives towards attaining increased range and reduced emissions.

2. LITERATURE REVIEW

According to a recent research conducted by environmentalists, the contribution of automobile sector in air pollution is almost 25%. This is a big concern and in order to reduce this, all automobile companies are coming up with electric cars as an alternative. Currently, the electric cars are using electric motor as a prime mover which uses the principle of electromagnetic induction. The idea of this project was to do further research to find an alternative for the electric motor.

The American scientist Joseph Henry constructed a small electromagnetic engine with a reciprocating beam and it was first described in American Journal of Science, 1831.

In 1838, F Watkins examined Henry's invention in detail and described it as the first cyclic electric motor, i.e. one that continued working without manual switching or resetting. Since then, continuous research has been going on to implement this concept on a large scale.

In this project, I have developed an electromagnetic prime mover as an alternative to the electric motor. This prime mover is designed based on the principle of electromagnetism and uses a solenoid and Internal Combustion Engine (ICE) working mechanism and thus, this concept is known as Solenoid Powered Engine (SPE).

3. COMPONENT

1. Crankshaft
2. Gears
3. L-Bracket
4. Solenoid Piston
5. Camshaft
6. Flywheel

4. MATERIALS USED

4.1 Stainless Steel:

- This medium carbon alloy provides high tensile strength and hardness. It has high resistance to bending and excellent weldability.
- Thus, Crankshaft, L-Bracket, Nut and bolt are made of SS.

4.2 Mild Steel:

- Due to low carbon content, mild steel has high tensile and impact strength and thus high resistance to breakage.
- Thus, flywheel and piston are made of mild steel.

4.3 EN-8:

- Unalloyed medium carbon steel has high strength compared to normal mild steel due to thermo-mechanical rolling.
- It has good Tensile Strength and is readily machinable.
- Thus, Spur Gears are made using this grade of steel because they undergo high levels of Stress and also to reduce the chances of Fatigue.

4.4 Solid Iron:

- It has high conductivity and it is malleable, ductile and strong.
- Thus, it is used to make the cylindrical solenoid.

4.5 Copper:

- It is ductile and a good conductor of electricity.
- Thus, it is used to make the wires which are wound around the iron conductor.

Table-1: Material and Component

Material	Component
Stainless Steel	Crankshaft, L-Bracket, Nut and Bolt
Mild Steel	Flywheel and Piston
EN-8	Spur Gears
Solid Iron	Solenoid
Copper	Wires

5. WORKING PRINCIPLE

5.1 POWER GENERATION:

i. A solenoid is a conductor around which copper wires are wound and when it is supplied with current, it generates a magnetic field.

ii. When current is passed through the wire, it produces magnetic flux which attracts any metal put inside the hollow pipe, towards it.

iii. Spark distributor is used to actuate electromagnet according to position of piston in cylinder rather than sensors and microcontrollers.

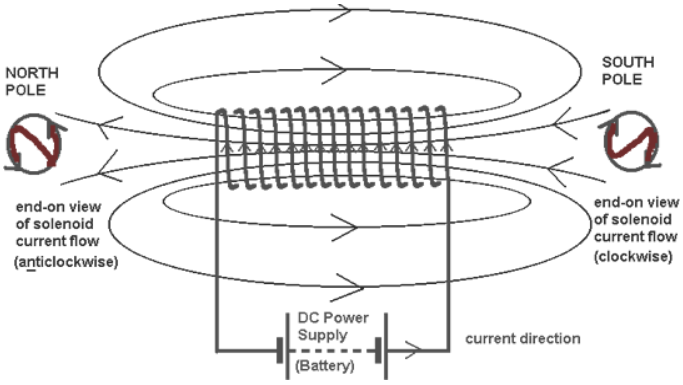

Fig-1: Electromagnetic waves in a solenoid

iv. Once the electrical supply is stopped, the solenoid loses its magnetism and the metal falls in its original position and if the supply is given again, the metal rises.

v. This TO and FRO motion of the metal is used to produce the mechanical energy required to run the engine.

vi. It is like the conventional IC Engine in which there is TO and FRO motion of the piston inside the cylinder.

vii. The firing order of the piston is 1-7-4-5-3-8-2-6.

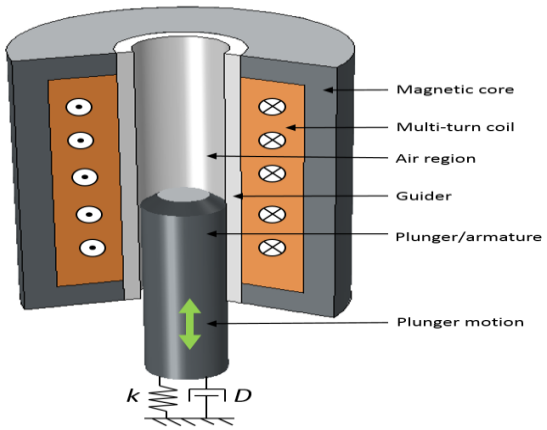

Fig-2: Linear Solenoid Actuator

viii. The reciprocating motion of the plunger is converted into rotating motion of the crankshaft.

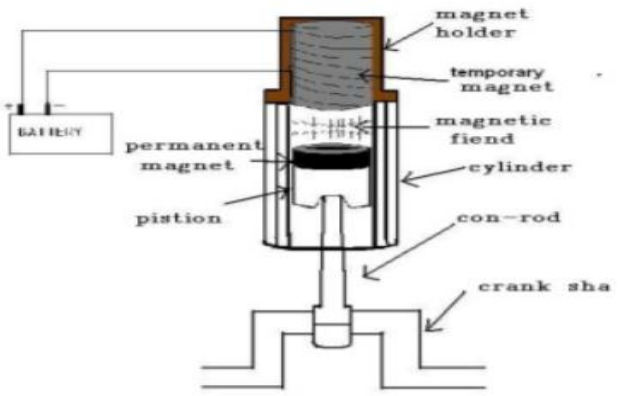

Fig-3: Magnetic piston operated engine

5.2 ACCELERATION AND BRAKING:

i. Battery is used to give electrical supply to induction coil and as main power source and it can be charged with an Alternator.

ii. There is a switch between solenoid coil and battery for connecting and disconnecting the supply to the coil.

iii. The main function of a **spark distributor** is to provide speed variation. It actually provides power to actuate the solenoids and control the movement.

iv. A **rheostat** is placed between the distributor with number of studs and it works as an accelerator.

v. When the value of resistance is decreased, more amount of current runs through the distributor and speed of movement increases. Thus, the rheostat acts as a variable resistor which can be used to control the current supply to the spark distributor.

6. CALCULATIONS

The calculations are done on exemplary basis-

1. BATTERY SPECIFICATIONS:

- 352V 120Ah

- 42.2kWh lithium-ion battery

2. SOLENOID PISTON SPECIFICATIONS:

-Bore: 94mm

-Stroke: 90mm

- Maximum force exerted by electromagnet on the piston-

$$F1 = (N2I2kA)/2G2 \quad \text{.....(i)}$$

Where,

N: no. of turns= 700

I: current flowing through the coil= 10A

K: permeability of free space = $4\prod x10^{-7}$

A: cross-sectional area of electromagnet=7.697×10^{-3}m

G: least distance between electromagnet and permanent magnet= 0.005m

Now, $$F1 = \frac{7002x102x4\prod x10\text{-}7x((\prod x0.0992)/4)}{2 \times 0.005}$$

$$F1 = 9479.735N$$

- Force exerted by the permanent magnet-

$$F2 = \frac{B2A}{2\mu_0} \quad \text{.....(ii)}$$

Where, B: Flux Density (T)
A: Cross-sectional area of the permanent magnet

- To find the flux density,

$$B = \frac{Br}{2}\left[\frac{D+z}{\sqrt{(R^2)+(D+z)^2}} - \frac{z}{\sqrt{(R^2+z^2)}}\right] \quad \text{.....(iii)}$$

Where, Br: Remanence field= 1.21T
Z: Distance from a pole face= 0.005m
D: Thickness of the magnet= 0.012m
R: Radius of the magnet= 0.047m

- Substituting the above values in equation (iii), we get-

$$B = 0.142T$$

- Now substituting the value of 'B' in eqn (ii), we get-

$$F2 = \frac{(0.142)^2 x((\prod x0.0942)/4)}{2 \times 4\prod \times 10^{-7}}$$

$$F2 = 55.69N$$

Since F1 and F2 are repulsive in nature, total force-

F= F1 + F2
= 9479.735N + 55.69N

F= 9535.425N

- Torque generated-

T= F x r
= 9535.425 x 0.045

r: crank radius
= half of stroke length
= 0.090/2= 0.045m

T = 429.09 N.m

- To calculate the RPM-

$$RPM = \frac{(\text{top speed}) \times 336 \times \text{gear ratio} \times (\text{overdrive})}{\text{Tyre diameter}}$$

$$= \frac{167\text{mph} \times 336 \times 2.95 \times 0.78}{24.7"}$$

RPM = 5227.27

- Output power generated-

$$P = \frac{2\pi NT}{60}$$

$$= \frac{2 \times \pi \times 5227.27 \times 429.09}{60}$$

P= 234.88 kW

The following vehicles have been carefully studied in order to design the proposed engine-

- **TVR CHIMAERA 500 (2003)**
- Capacity: 4988 cc (V8)
- Power: 254kW/ 340 bhp @5500 rpm
- Torque: 434N.m @4000rpm
- Top speed: 167mph / 270kmph
- Tyre size: 245/45ZR-16
- Gear ratio: 2.95:1
- **BMW i3 (2019)**
- Battery: 42.2 kWh
- Range: 246 km
- Supply: 350v 120Ah

7. RESULT

7.1 Comparison of the engine output

ENGINE	TORQUE GENERATED	POWER OUTPUT
TVR CHIMAERA 500 (4988 V8)	434 N.m	254kW@5500rpm
SOLENOID ENGINE	429.09 N.m	234.8kW@5227rpm

7.2 Comparison of engine weight of the same capacity-

ENGINE	KERB WEIGHT
TVR CHIMAERA 500	250 kg
SOLENOID ENGINE	308.6 kg

- Thus, the solenoid engine is approximately **1.23** times heavier than the TVR Chimaera Engine of the same capacity.

8. STRUCTURAL DESIGN

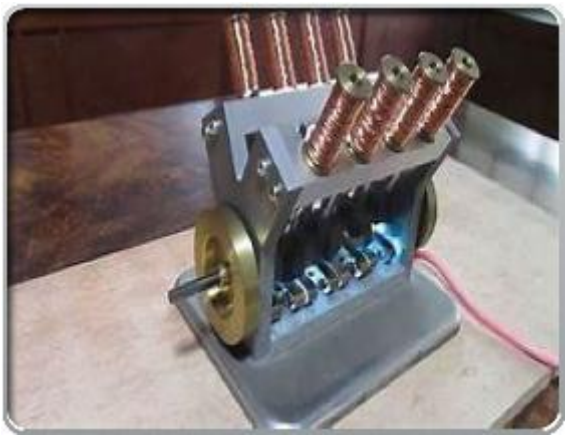

Fig-4: V8 Solenoid Engine

9. CONCLUSIONS

The project aims at efficient working of an electric vehicle powered by a group of solenoids. A battery is used to supply current to the solenoid and also used to run the auxiliaries which are included in an automobile. The piston is designed using the solenoid concept and the power train follows the IC engine mechanism.

This concept is proposed keeping in mind the gradually increasing prices of fossil fuels and pollution caused by them. It may require a high initial investment compared to the conventional gasoline engine cars but it will prove to be efficient and save a lot of money in the long run.

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BIOGRAPHY

Mr. Sarthak Raisoni is currently pursuing his Final Year B.Tech course in the Department of Mechanical Engineering from MIT World Peace University, Pune, Maharashtra.