Microcontrolled Electromagnetic Engine

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Abstract—This paper presents an idea for an Electromagnetic Engine. It is a modification of conventional internal combustion engine. As the fossil fuels are prone to extinction, thus this proposed idea is an attempt to get rid of the conventional fossil fuel engines. Proposed work uses the electromagnetic force to drive the piston and produce power. The concept of changing the direction of current and hence the polarity of magnetic field thus producing attractive and repulsive forces in succession has been used by which we get reciprocating motion which will drive the crankshaft and the motion will be converted into rotary motion as given by any conventional engine. Proposed engine’s working is similar to a two-stroke internal combustion engine as power at piston head is generated in each cycle revolution of shaft.

Keywords—2-Stroke Engine, Electromagnet, Electromagnetic Engine, Microcontroller.

I. INTRODUCTION

THE use of internal combustion engine has been predominant for a long time, for automotive purposes which uses Diesel or petrol for providing the required energy [1]. In I.C engine when the piston is close to Top dead center, the compressed air-fuel mixture is ignited, usually by a spark plug [4]. The resulting massive pressure from the combustion of the compressed fuel-air mixture drives the piston back down toward bottom dead center with tremendous force. This is known as the power stroke, which is the main source of the engine's torque and power in conventional engine.

The working of a two stroke engine can be understood by figure.1. In two stroke engine the cycle is completed in one revolution of the crankshaft. Two strokes are sufficient to complete the cycle, one for compressing the fresh charge and the other for expansion or power stroke. The air or charge is inducted into the crankcase through the spring loaded inlet valve when the pressure in the crankcase is reduced due to upward motion of the piston during compression stroke. After the compression and ignition, expansion takes place in the usual way.

II. PROPOSED METHODOLOGY

A. Working Principle:−

The basic principle behind the proposed mechanism lies in the concept of simple magnetism properties, viz. same poles repel each other and opposite poles attract each other [2].

B. Implementation

This paper proposes the idea for electromagnetic engine, which consists of a pair of electromagnets. One of which is moveable inside the cylinder at the piston head and other is fixed as the cylinder head of the engine. The change in
direction of current of the fixed electromagnet, which consequently changes the polarity of the electromagnet from south to north and vice-versa [3], is achieved by using a micro controller coupled with high rating current regulator. The polarity of the moving electromagnet is fixed. Hence the fixed electromagnet will attract and repel the moving electromagnet. Thus it will produce a reciprocating motion and by the help of connecting rod and crankshaft this reciprocating motion is converted into rotary motion. This is further explained in the following subsection.

C. Schematic Diagram

The working methodology is explained by figure 2 and figure 3.

Here A denotes the stationary electromagnet (engine head) and B denotes the movable electromagnet (piston head).

Fig.2 When the piston is at TDC the polarity of both the electromagnets are same due to which a repulsive force act on the piston head to push it down which is as same as the gas force act on the piston head in conventional engine during power stroke.

Fig.3. When the piston is at BDC the polarity of the fixed electromagnet changes and it attracts the piston toward it and the piston moves upward. This process is repeated for further cycles. This process is controlled by microcontroller.

III. Block Diagram

The working of the proposed engine can be well studied by going through the following block diagram.

As shown in the block diagram the main components required are battery (power source), high rating current controller, microcontroller and the electromagnetic engine with proper windings.
A. Battery

Battery is used as an alternate source of power instead of the fossil fuels. Lithium batteries with higher power ratings are available at relatively cheaper cost and with high duty cycle, they serve perfectly for application in an electromagnetic engine. Lithium batteries are relatively lighter in weight and can be combined to give desired power rating [6].

![Fig.5 LEC33H and LEC24H single cell](image)

### Specification of single cell of LEC33H and LEC24H

<table>
<thead>
<tr>
<th>Cell model</th>
<th>LEC33H</th>
<th>LEC24H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal voltage (V)</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Capacity (Ah)</td>
<td>33</td>
<td>24</td>
</tr>
<tr>
<td>Size (W x L x H) (mm)</td>
<td>45 x 109 x 192</td>
<td></td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Specific energy (Wh/kg)</td>
<td>62</td>
<td>45</td>
</tr>
<tr>
<td>Specific power (W/kg)</td>
<td>1440</td>
<td>1500</td>
</tr>
<tr>
<td>Specific recharge power (W/kg)</td>
<td>460</td>
<td>1000</td>
</tr>
<tr>
<td>Number of cells in battery</td>
<td>180</td>
<td>170</td>
</tr>
<tr>
<td>Total voltage (V)</td>
<td>648</td>
<td>612</td>
</tr>
<tr>
<td>Total output (kW)</td>
<td>450</td>
<td>460</td>
</tr>
<tr>
<td>Total input (kW)</td>
<td>150</td>
<td>300</td>
</tr>
</tbody>
</table>

* with 50% SOC after 10 s

B. Microcontroller

Microcontroller is used to control the rpm of the motor by controlling the frequency of current supplied to the winding of the stationary electromagnet via current controller.

At mega 8 is used in proposed work which has 8 bit timer/counter [7], whose salient features are
- Single channel counter
- Frequency generator
- External event counter

![Fig.6 8-Bit Timer/counter Block Diagram](image)

C. Current controller

It is used to provide the adequate current to the electromagnet which is controlled by microcontroller. It is very essential as the force developed at piston head is dependent on the current supplied.

IV. Design Methodology

A. Assumptions

For conventional I.C. engine:-
- Bore = 42mm
- Stroke = 43 mm
- Gas pressure = 700 psi = 4826330 Pascal

For proposed electromagnetic engine:-
- Diameter of piston = 140 mm
- Length of piston = 60 mm
- Distance between two electromagnets at TDC = 20 mm
- Distance between two electromagnets at BDC = 70 mm
- No. of turns of wire for winding = 400
- Current supplied = 20 ampere

B. Calculations

For conventional I.C. engine:-

\[
\text{Area of piston head} = \frac{\pi d^2}{4} \tag{1}
\]

Where \( d \) is diameter of the piston head.

So Area of piston = 1.38544*10\(^{-3}\) m\(^2\)

\[
\text{Force} = \text{Pressure} \times \text{Area}
\]

\[
\text{Force} = 4826330 \times 1.38544 \times 10^{-3} \text{ N/m}^2
\]

\[
\text{Force} = 6686.59 \text{ N/m}^2
\]

For proposed electromagnetic engine:-
Force between two identical electromagnets is given by (2)

\[ F = \frac{B_0^2 A^2 (L^2 + R^2)}{\pi \mu_0 L^2} \left( \frac{1}{x^2} + \frac{1}{(x + 2L)^2} - \frac{2}{(x + L)^2} \right) \]  

(2)

Where;

- \( B_0 \) is the magnetic flux density very close to each pole, in Tesla (T),
- \( A \) is the area of each pole, in \( m^2 \),
- \( L \) is the length of each magnet, in m,
- \( R \) is the radius of each magnet, in m, and
- \( X \) is the separation between the two magnets, in m

So, by using the above formula we get:

- \( F = 8905.63 \) N/m² at TDC
- \( F = 451.30 \) N/m² at BDC

TDC stands for Top Dead Centre
BDC stands for Bottom Dead Centre.

V. COMPARISON

The proposed electromagnetic engine uses electric power to run which is cleaner and cheaper than fossil fuels. In an internal combustion engine the problem of heating is there but for the proposed engine there is no such problem. The proposed engine is a comparison with a 70cc internal combustion engine. It is visible from the above calculations that the force is produced twice in the proposed engine that is repulsion force at TDC and attraction force at BDC but in conventional engine pressure is applied at piston head only when it reaches the TDC, thus proposed engine is more powerful than the conventional engine.

As the proposed engine works on a direct current supply from a battery, it can be easily coupled with photovoltaic cells in order to charge the batteries.

VI. CONCLUSION

The paper proposes an idea of electromagnetic engine which uses the property of an electromagnet by virtue of which it changes the polarity of its poles whenever the direction of current entering the windings is changed. The proposed engine has been made in comparison with a 70 cc conventional internal combustion engine.

The advantages of electromagnetic engine are:

- Totally green engine.
- Light weight
- Low running cost
- Less maintenance
- Less manufacturing cost.

In order to design an engine with a high power rating this idea can be extended in various models of internal combustion engines such as boxer engine, multi-piston-single-shaft engine.

REFERENCES