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Research Article

Design of Cyclotron Amplified Impulse Reciprocating Electromagnetic Engine

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Abstract

When the world started running at faster pace there is requirement of a speedy transport medium which lead to discovery of an Internal Combustion Engine. This type of engines requires the chemical power to operate which can be supplied through fuels but these fuels are depleting and they are non-renewable source of energy. This may show a worst scenario to the world after their depletion. So we focused on alternate sources which can work equally as the IC engines that is an Electromagnetic Engine. These type of engines were discovered but to increase the input power and also to obtain a good torque as output we planned to amplify the input signal using a CYCLOTRON. These cyclotrons are employed in impulse-jet rocket motors so we want to apply this concept theoretically in reciprocating engines.

Keywords: *Cyclotron, Reciprocating Electromagnetic Engine etc.*

Introduction

IC Engine is a mechanical device which converts chemical energy to mechanical energy by continuous cyclic processes which is done by a reciprocating piston in its cylinder which in turn rotates crank shaft connected to it to convert the reciprocating motion into rotary motion for this crank-slider mechanism is employed. The overall output of the internal combustion engine is Torque. There are two types of IC engines they are spark ignition engine and compression ignition engine which are using Gasoline and Diesel as fuels. This engine is again classified according to the number of strokes employed in it to complete one revolution of the crank shaft it is a two stroke engine and four stroke engines.

In these days also six stroke engines are discovered. The cyclic process in these engines is opening of inlet fuel valves injection of fuel for combustion also a spark in case of spark ignition engine and opening of outlet valves for elimination of exhaust gases in the combustion chamber. There are many operational troubles in these engines as the timing of the every task must be perfect in the engine so efficiency of engine decreases automatically as the timing is required it employs a lot of mechanisms and gear trains so the efficiency decreases due to errors in every system. Also the types of fuels used in this engine are non-renewable type and the yield in pollution. After depletion of these fuels there will be probably no use of these engines under researches many types of alternate fuels are discovered but these also yield in pollution and other harmful gases which are slow poison for mankind e.g.:-methanol, propane etc. To eliminate the pollution and other problems for man-kind electromagnetic engines are employed but these engines cannot output torque as an I C engine also their coils may ignite if heavy load is applied on them while running.

So we came with a new engine which will employ a cyclotron and the electromagnetic principle for it's running. It will get its primary impulse from a cyclotron and it is supported with the magnetic repulsion force created by the copper coils around the cylinder. So it will get enough power to run like a I C engine having same specification such as inputs and output.

Literature Survey

It was studied from the article Electric Reciprocating Engine K.Muralidharan *et al.*

Working Principle

It's basically a practical approach to Farady's laws. When both the permanent and electron magnets are engaged perpendicular to each other as per inversion any of them will act as a core and it will get a push due to the magnetic repulsion.

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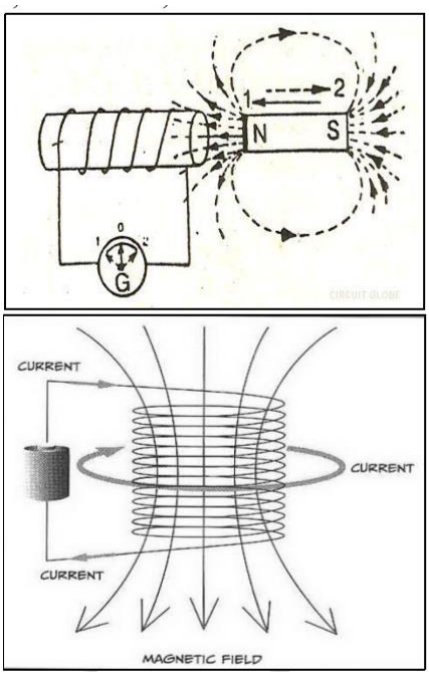


Fig.1 Working of an electric reciprocating engine

Components

Basically for this type of engine the cylinder must be nonmagnetic so we can employ composites in order to decrease weight, or Aluminium. It must have low electrical conductivity and high resistivity and also should be light it weight. Low amount of heat is produced so there is no requirement of larger area for heat transfer so fins can also be eliminated. B. Piston Piston of this engine is a hollow casing made of nonmagnetic material similar to that of cylinder. It must have high resistivity and low electrical conductivity. Materials like stainless steel or aluminum can be used. A permanent magnet is attached to the hollow piston casing. Material of permanent magnet must produce high magnetic field strength. The flat top surface of permanent magnet is made to face the cylinder head. The other side of piston is connected to Connecting rod. C. Connecting Rod and Flywheel The connecting rod and flywheel can be used as same as in IC engines without any modifications. The connecting rod

Study of Electric Reciprocating Engine

It can also be made of non-magnetic material to avoid interferences of magnetic field. D. Electromagnet The electromagnet is an important component of this type of engines. Electromagnets are made by winding insulated copper wires over the cylinder. The copper wires are coated with insulating material. The electromagnet is energized, it produces magnetic field which called as the reciprocating motion of the piston. E. Battery any battery can be used but when high values of load current are necessary. In this engine 48V 10Ah or 20Ah lithium or a lead acid battery is used. The minimal requirement of starter motor is around 6V-12V, hence a 48V battery is enough to drive the engine. F. Relay is an automated impulse generator. It controls the power supply to the electro magnet. Basically it is an electrical control mechanical switch, it can also be electronic triggering device with higher loads can be powered and unpowered with Desired input of current and also voltage. G. Speed Regulator Speed regulator is a device which is used to vary flow of current thereby varying speed of engine. An Electronic Speed Controller can be used to regulate the flow of current. An Electronic Speed Controller (ESC) is an electronic circuit used with a purpose to vary speed of this engine and also to act as a dynamic brake. An ESC is a standalone unit which plugs into receivers throttle control channel or incorporated on receiver to control the speed of engine.

Charging System

Generally in electric vehicles, charging of battery can be done with an electric grid. The concept of Grid-To-Vehicle (G2V) is a simplest process of integration of electric vehicle's battery charging system with power grid which enables the flow of energy from power grid to batteries. Also battery can be charged with a Dynamo/ Alternator by engaging an alternator with the crankshaft or with the wheels.

Key points

According to the power output required, number of batteries required increases.

- Speed increases with increase in current.
- Windings must be tight and machine wound.
- Windings must be insulated to avoid drop of efficiency.

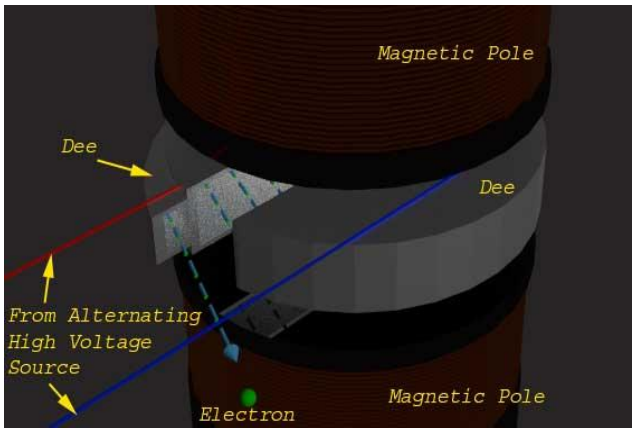
Accordingly we planned for design of electromagnetic engine having input amplified by a cyclotron

Cyclotron

It is a particle accelerator which functions between strong electromagnets and permanent magnets and it's output is charged particles with high kinetic energy.

Cyclotron parts: This device basically has three main constructional parts

1.Two electromagnets
2.Two half cylinders in shape of dees having concentric circular paths within them
3.AC source of high frequency



Constructional Details

The dees are placed face to face and the Electromagnets of opposite poles are perpendicular to each other dees are connected to a high frequency alternating source. Radius of each concentric level in dee is calculated with below formula.

$$R_1 = \frac{m\nu}{qB}$$

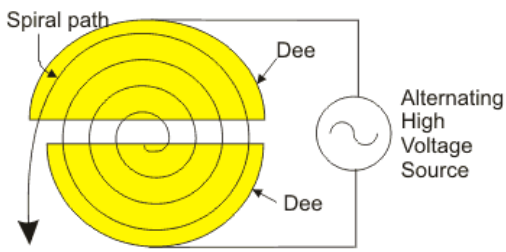
Where, m is the mass and q is the charge of the thrown particle and B is the flux density of externally applied perpendicular magnetic field.

As the revolving particle will get to edge of dee and as these dees are supplied with opposite polarity the particle is attracted in to another dee

That the polarity of the other Dee is opposite to it due to that attraction and the repulsion from the previous dee the particle gains some kinetic energy the magnitude of it can be calculated using the below formula.

V1= velocity in new dee
v2= velocity in old dee

$$qv = \frac{1}{2}m(\nu_2^2 - \nu_1^2)$$



Theoretical Analysis

The Maruti Zen engine is considered and it has a four cylinder engine mounted with carburetor using petrol engine volume is 993 cc. Max Power is 60.9 PS (45 kW; 60 hp) at 6000 rpm and max output torque is 78.48 N-m at 4500 rpm. Bore=72.0mm; Stroke=61.0 mm: volume ratio before and after compression 9.4:1.

Table 1 Parameters of an IC Engine

S.no	Parameters	Ideal	Loaded
2	Brake Power	------	36.982 kw
4	B.M.E.P	-------	3.171 kn/m^2

The current electromagnetic engine is designed according to these parameters. Only singe cylinder parameters are considered out of four cylinders. Considering 993 cc I C Engine for comparative design of Electromagnetic Engine.

993 cc = (248.36*4)cc
Bore * stroke= 72.0*61.0/10 cm
volume ratio before and after compression= 9.4:1
Maximum Brake power = 36.45 Kw
Maximum torque = 78.48 N-m
Speed = 4500 rpm
Max pressure requirement = 12.684 Kn/m^2

Formulation according to dimensional analysis to obtain pressure from kinetic energy

For converting the kinetic energy to pressure a diffuser must be used which will have a throat when we send higher masses of particles into a less cross-sectional area the pressure increases automatically so the clearance volume is chosen as less cross-sectional area and when we send the higher mass at higher flow rates. So this calculation is to decide the mass flow rate to create a pressure of 12.684 KN/m^2.

Assumption in dimensional analysis

Kinetic energy's unit is kg m^2/s^2 so when it is divided by the area of electron ejector gun of cyclotron we get kg square meter/(square second*square meter)=kg/square second when it is again multiplied by time for which mass flow into clearance volume (kg/s^2)*s=kg/s when it is multiplied by length of the clearance volume (kg/s^2)*l=kg-m/(S^2)

So finally the output is force kg-m/(s^2) which is equal to 1N when this is divided by clearance area then it will become N/(m^2) the conversion of the kinetic energy into pressure can be done in this case by using the Eq. **P =(KE*L/(Area of electron ejector gun*length of clearance vol)) N/m^2**

Design of cyclotron

The cyclotron design is done by the pre-assumption of the kinetic energy output required from the cyclotron.

As there is a requirement for converting the kinetic energy to pressure we directly done the calculations according to the assumed formula.

Area of electron gun = 0.1*0.1m
Clearance volume = 2.4836*10^-4

Length at clearance volume = 1.0979*10^-3
Pressure output required = 12.684 KN/m^2
On calculation **K.E = 28.6929 Kg-m^2/s^2**

Therefore to design the cyclotron for above mentioned kinetic energy we had calculated the required velocity in each circular path.

Table 2 Velocities of particles in successive circular path

V1	3.9705*10^15
V2	5.6152*10^15
V3	6.8772*10^15
V4	7.9411*10^15

Table 3 The corresponding radius of successive circular paths

R1	0.225m
R2	0.319m
R3	0.3911m
R4	0.4516m

Advantages

- No exhaust of harmful gases.
- No need of heavy cast iron vessels for enclosing the engine.
- Can give better performance than electric bikes.
- Errors can be reduced as there is no special gear drive for valve opening closing
- Spark plug not required

Disadvantages

- Effect of radiation can be very high due to leakage of charged particles in unpredictable spectrum.
- Total composite material cost to fabricate an engine is very high.
- Number of practical implementations to implement it for multi cylinder engine is very high.
- Risk of electric shocks or electric short circuit in pouring H2O or other electrolytes.

How this Kinetic Energy helps

This Kinetic energy helps to create the pressure required for the piston to travel down during power stroke.

How to convert kinetic energy to pressure energy

Kinetic energy to pressure conversion can be achieved by using a purposefully designed nozzle which have higher cross-section at one end lower cross-section at another end. so if more amount of particles with high kinetic energy are sent fro electron gun to the smaller clearance volume in the cylinder the pressure increase abruptly and the piston travels down due to this power stroke. (e.g:- diffusion in rocket)

How to obtain such a pressure in less time

By controlling the unwanted mass flow rate we can cut of the flow of the particles directly in to cylinder by adding a reservoir. Such that only for power stroke the electrons will be set in from reservoir at higher mass flow rate.

Discussion of Results

The results obtained are sufficient to build a cyclotron amplified electromagnetic engine which is comparatively equal theoretically to an I C engine. This theoretical analysis is done to confirm that we can run an engine which is substitute for the I C engine.

Summary of Work Flow

1) Comparison with I C engine for desired results.
2) Power and Dimensional calculations.
3) Design of engine.
4) Assumption for formulation to convert kinetic energy to pressure.
5) Obtaining velocities.
6) Assumptions of parameters for cyclotron design.
7) Design of cyclotron.

Conclusion

This design is done only on pure assumptions it will take a higher period of time and very sophisticated equipment to realize the components

Friction is not considered while calculations of power this may become the major disadvantage while realizing.

The cyclotron design with the mentioned specifications is very troublesome as it is difficult to run particles at such huge velocities in small areas as the risk of explosion is high it can be done by using a very specially designed composite materials for realization.

Recommendations

If the fabrication of such small cyclotron is difficult it can be used in thermal power plants to conserve the renewable energy sources also in aircraft also where there is need of higher torque output and there is more space for conventional engine.

Over view

Just convert the kinetic energy from cyclotron to pressure and directly give this pressure onto piston as a power stroke.

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