DESIGN OF PERMANENT MAGNET RECIPROCATING ELECTRICITY GENERATOR

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***Abstract*--Energy demand is increasing day by day with rapid growth in industrial as well as house hold utilization. But the energy resources are gradually decreasing at a higher rate. With this scenario the energy resources would come to an end within a few years and hence there will be scarcity of fuel. In the last two decades we had invented many methods to harvest the energy. Only few of these methods accomplish it without burning fuels. This paper presents an innovative design of magnetic reciprocating generator which no longer burns any kind fuel for energy production. The machine works on the principle of magnetic attraction and repulsion. Magnetic field between the pair of permanent strong magnets is reversed intervallic to get the reciprocating motion. Later the reciprocating motion of one of these magnets is converted to useful rotational motion using slider crank mechanism. This rotational motion when fed to dynamo generates electricity. Two longstanding aim of this new system is to reduce the fuel consumption and to increase the overall performance of the energy production. The model has been designed using CATIA V5.The working of the proposed machine is explained in detail with 2D and 3D sketches. This new concept of electricity generation will revolutionalize the energy production, saving the renewable sources to a great extent.**

***Index terms*-- Permanent magnets, Reciprocating motion, Slider crank mechanism, Dynamo, Electricity, Design, Results.**

1. INTRODUCTION

Electrical energy is vital but there is lack of fuel to produce this energy. Present day generators use non-renewable resources. These include fuels such as coal, petrol and diesel predominantly. There is a known threat of depletion of these fuels. Coal burnt in large power plants is obtained by mining which has an adverse effect on the geography and they emit enormous amount of harmful gases in to atmosphere. On the other hand the generators working on internal combustion engine are very less efficient. Investment and running cost of fuel burning generators is very high. These machines also require frequent maintenance. There is a great need for a new technology which overcomes the above mentioned conflicting objectives. The technology which no longer uses fuels, is affordable and requires very less maintenance. One of these methods includes the use of magnetic energy from permanent magnets to produce electrical energy [4]. Magnetic field between the pair of magnets is reversed intervallic to get the reciprocating motion. Later the reciprocating motion of one of these magnets is converted to useful rotational motion using slider crank mechanism[2]. Two decades ago, few people have patented the idea of Electromagnetic Reciprocating Engine. In their design, they have replaced combustion by magnetism[3]. In this project our purpose is to generate electricity using Permanent Magnetic Reciprocating setup.

2. CONSTRUCTION

Design of the model is done in CATIA V5 R20 designing software. Assembly model of the concept is shown in figure 1. Assembly consists of principal components which involve in dynamics of machine. Entire assembly is supported by a rack. Rack is a thick plate made up of non-magnetic aluminium alloy. Rack has four arms which are grooved with slots

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of 180mm length and 17mm thickness.

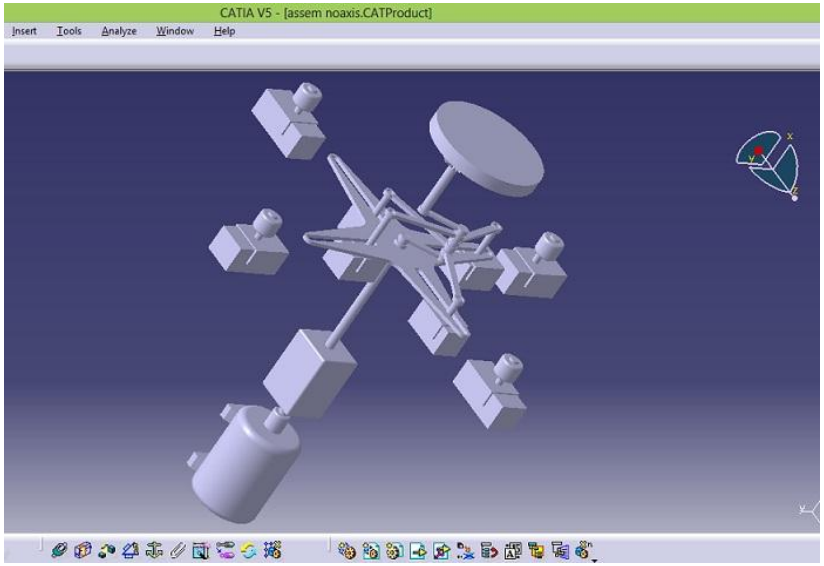

Figure 1 CATIA 3-D Isometric view of Principal components assembly.

The 3-D model of assembly of rack, inner magnets, outer magnets, crank shaft, connecting rods, fly wheel ,Gearbox and dynamo is shown in the figure 1.

Slots are the guide ways in along which inner magnets reciprocate. There are four such inner magnets of in the assembly as shown in figure 2. They are neodymium magnets of size 100mm×65mm×50mm. Four similar magnets are placed outer side of the top dead centre of each inner magnet. Outer magnets are comparatively bigger in sizing 140mm×70mm×50mm. Both inner and outer magnets are coated with Giron. Giron is a magnetic shielding sheet material. Four stepper motor [NEMA-17] are used to rotate outer magnets. One stepper motor is mounted on each outer magnet.

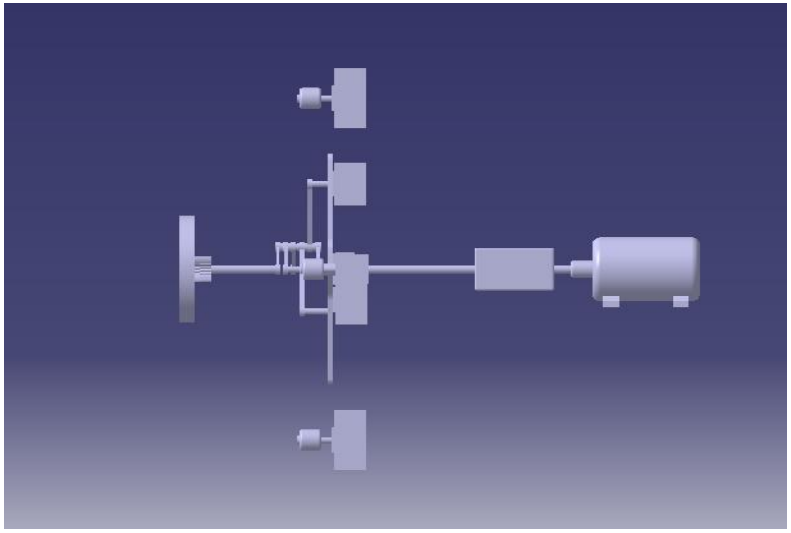

Figure 2 CATIA 3-D side view of final assembly.

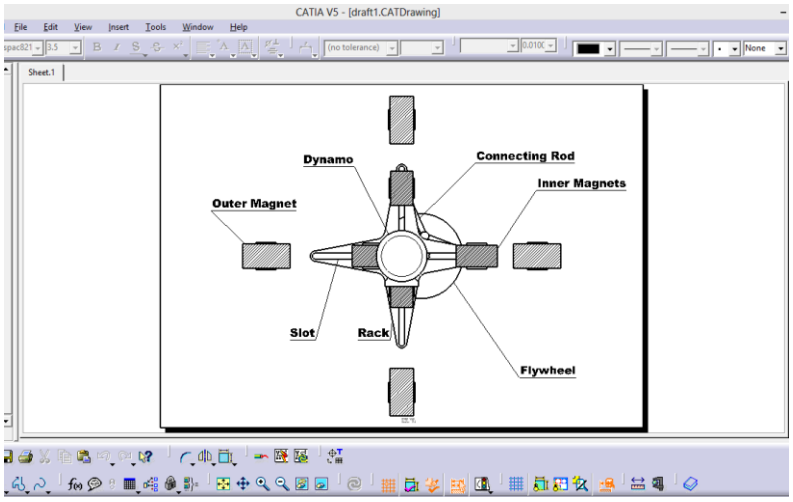

Figure 3 CATIA 2-D draft of assembly with name of the components.

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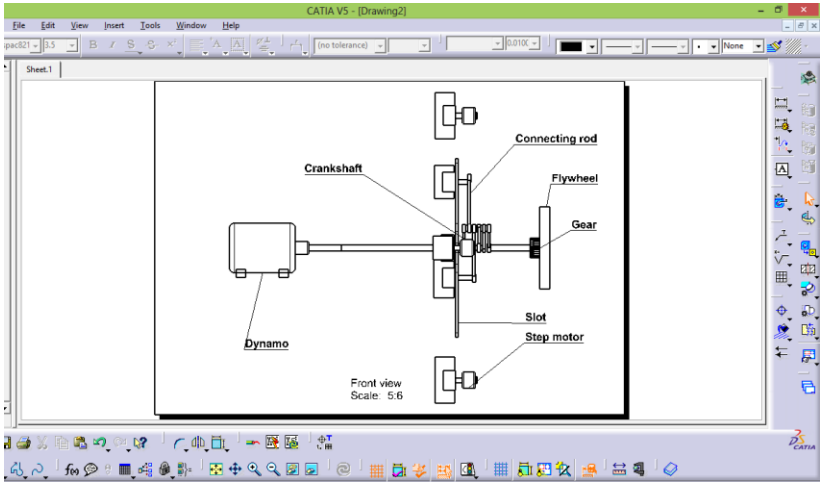

Figure 4 CATIA 2-D Side view of the assembly.

Connecting rod connects inner magnet to the crank shaft. Each rod measures 165mm in length. Crack shaft is self-balanced and converts reciprocating motion in to rotary motion. Centre shaft is extended on one side of the plane of operation and is connected to flywheel. One the other end it is connected to gear box. Gear box converts high torque rotation in to high speed rotation. This helps in generating high voltage current output. Dynamo is placed on the same central axis after the gear box. Dynamo and gear box are linked using a small shaft.

3. FORMULAE

a) Force between two bar magnets [5];

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

Where;

B_0 = Magnetic flux density

A = Area of each pole in meter^2

μ_0 = Magnetic permeability constant

L = Length in meter (m).

R = Radius of each magnet in m

x = separation between magnets in m

b) Step angle of stepper motor;

$$\text{Step angle} = \left(\frac{N_s - N_r}{N_s N_r}\right)\times 360$$

Where;

N_s = number of teeth on stator

N_r = number of teeth on rotor

c) Torque on the centre shaft;

T = F× D

Where;

T = Torque in Nm

F = Magnetic force in N

D = distance in m

d) Power generated by dynamo [1];

$$P = \frac{T_{Nm} * \omega_{rpm}}{9549} \quad \text{kilowatts}$$

4. WORKING

The mechanism is initiated by giving a small revolution to the flywheel. This initial energy is considered as external force. On initiation, a couple of inner magnets move outwards while two of them slide inwards. At the same time, outward moving magnets experience attractive force and inward

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moving magnets feel repulsive force due to outer magnets. The magnitude of this force is given by the formula .

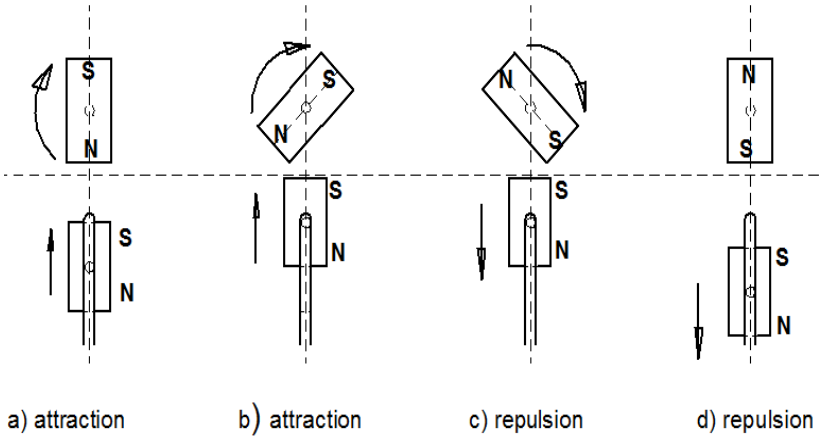

Figure 4 SOLID EDGE V19 DRAWING of sequence of events taking place during the inversion of polarity. Magnets bellow and above the horizontal dotted line are inner magnets and outer magnets respectively.

As one of the outward moving inner magnet approaches outer magnet, the switch near top dead centre of the stroke is closed. This switch actuates the stepper motor. Every time the switch is closed, the stepper motor completes 100 steps rotating the outer magnet by 180˚. During this interval the inner magnet would complete the stroke and start moving downward. Now this couple of magnets experience repulsive force between them due to change in polarity of the outer magnet [figure 4].

The same action takes place in between all couple of magnets. Every inner magnet travels the stroke twice during one complete rotation of crank shaft. This mechanism is similar to the two stroke Internal Combustion Engine consisting of four radial cylinders. The events taking place when one of the inner magnet approaches respective outer magnet is shown in[figure 5].

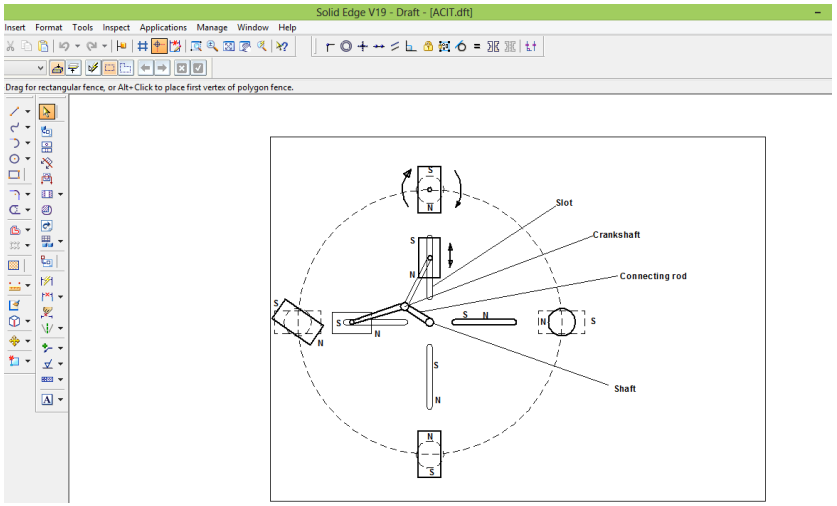

Figure 5 SOLID EDGE V19 DRAWING. This figure shows the events taking place when one of the inner magnet approaches respective outer magnet.

Torque is exerted on the crankshaft which is equal to four times the magnetic force between two magnets multiplied by radius of crank circle. Torque is calculated using the suitable formula. This torque makes centre shaft to rotate. Flywheel at one end of the shaft maintains the uniform angular velocity. Shaft on the other end is connected to the gear box. Gear box converts high torque rotary motion in to high speed motion. Finally output from the gear box is fed in to dynamo. Thus dynamo transforms rotational energy to electrical energy.

5. CONCLUSION

Compared to the existing power generation methods, magnetic reciprocating generators will prove to be a revolutionary mode of energy production. The design is technically advanced hence machine suffers lesser energy losses due to friction. As working of machine does not involve combustion, no heat is produced. Absences of heat and less friction make the machine more durable. This system can be installed even in the populated areas since it doesn't require any fuel. This is also a part of green technology since it is a pollution free energy production. This reliable

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pollution free energy source can be easily in roofs of buildings and houses to meet their power requirements. Conventional energy harvesting system can be replaced by highly reliable acoustic efficient magnetic generator mechanism.

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