

Generation of Electricity from Free Wheeling System Using Bevel Gear Arrangement

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Abstract--- Nowadays, electricity generation has been a great concern. There is shortage in power production all over the country. Especially, in south India there is been frequent power cut for hours. Power produced does not meet the requirements. However, power can be produced by other means, which would find usage in small application.

This project deals with production of power using a dynamo. In day to day life there are lots of equipments which could be used to convert mechanical work into power. The most commonly used systems are wheeling systems. Wheels have rotational motion. When a dynamo is attached to the wheel by means of some arrangement, rotation in the wheel will lead to dynamo action taking place resulting in generation of power.

Bevel gear arrangement is made here. Bevel gear is arranged in such a way that one gear is larger in size comparing other. The ratio is 1:3 (i.e.) for one rotation in wheel there is three rotations in the dynamo. Thus, dynamo rotation is three times the rotation of wheel (dynamo rotation = 3* rotation of wheel).

Wheels have rotational motion which could be used to run a dynamo to produce power. This rotational motion is mechanical energy which is converted into electrical energy, thereby generating power.

This project deals with three main applications to be used in production of power

- 1) Wheels of a bicycle is connected to the dynamo which will produce small amount of power which is essential to run few LED'S using a small storage battery
- 2) Wheels of cycling machine used in GYM which are used for hours daily can be used to produce continuous power which is similar to power produced in a bicycle.
- 3) Wheels of an automobile which rotate at high speed at an average of 50-60 km/hr. They can produce large amount of power which can be used to charge the batteries used without consuming the fuel.

I. INTRODUCTION

A. *Dynamo theory:*

Walter Maurice Elsasser was a German-born American physicist considered a "father" of the presently accepted dynamo theory as an explanation of the Earth's magnetism. He proposed that this magnetic field resulted from electric currents induced in the fluid outer core of the Earth. He revealed the history of the Earth's magnetic field through pioneering the study of the magnetic orientation of minerals in rocks. He published papers describing the first mathematical model for the origin of

the Earth's magnetic field. He conjectured that it could be a self-sustaining dynamo, powered by convection in the liquid outer core, and outlined a feedback mechanism between flows having two different geometries, toroidal and poloidal (indeed, coining the terms).

B. *Peddalling system:*

A bicycle pedal is the part of a bicycle that the rider pushes with their foot to propel the bicycle. It provides the connection between the cyclist's foot or shoe and the crank allowing the leg to turn the bottom bracket spindle and propel the bicycle's wheels. Pedals usually consist of a spindle that threads into the end of the crank and a body, on which the foot rests or is attached, that is free to rotate on bearings with respect to the spindle.

Pedals were initially attached to cranks connecting directly to the driven (usually front) wheel. The safety bicycle, as it is known today, came into being when the pedals were attached to a crank driving a sprocket that transmitted power to the driven wheel by means of a roller chain

C. *Bevel gear*

Bevel gears are gears where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. Bevel gears are most often mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well. The pitch surface of bevel gears is a cone.

Two important concepts in gearing are pitch surface and pitch angle. The pitch surface of a gear is the imaginary toothless surface that you would have by averaging out the peaks and valleys of the individual teeth. The pitch surface of an ordinary gear is the shape of a cylinder. The pitch angle of a gear is the angle between the face of the pitch surface and the axis.

The most familiar kinds of bevel gears have pitch angles of less than 90 degrees and therefore are cone-shaped. This type of bevel gear is called external because the gear teeth point outward. The pitch surfaces of meshed external bevel gears are coaxial with the gear shafts; the apexes of the two surfaces are at the point of intersection of the shaft axes.

Bevel gears that have pitch angles of greater than ninety degrees have teeth that point inward and are called internal bevel gears.

Bevel gears that have pitch angles of exactly 90 degrees have teeth that point outward parallel with the axis and resemble the points on a crown. That's why this type of bevel gear is called a crown gear.

D. *PRINCIPLE OF DYNAMO:*

The generation of electricity by a dynamo is based on a principle of magnetism called induction. When the lines of

force that pass from the north to the south pole of a magnet are cut by a wire there is produced or induced in the wire a current of electricity. That is, if we take a loop or coil of wire which has no current in it and a magnet which also has no current, and move the loop or coil between the poles, as shown in Fig. 83, a momentary current is produced. If a series of loops or coils are used instead of one loop, a current may be generated continuously. This method of generating electric current is called induction.

The strength of a current in electromotive force set up by induction depends upon: (1) the strength of the magnet, (2) the number of turns of wire in the coil or loop, and (3) the speed with which the magnetic lines of force are cut, that is, the speed at which the coil rotates.

E. Direction of Induced Current

The direction of an induced current depends upon two factors: (1) the direction of the motion of the wire, and (2) the direction of the magnetic lines of force.

A very valuable method of determining the direction of current used in practical life is called Fleming's Rule.

Place the thumb, forefinger, and centre finger of the right hand so as to form right angles to each other. If the thumb points in the direction of the motion of the wire, and the forefinger in the direction of the magnetic lines of force, the centre finger will point in the direction of the induced current.

It is very important to know the direction of the current in revolving a loop of wire between the poles of a magnet in order to understand the working of a dynamo.

Figure shows, loop of wire between the poles of the magnet. If the loop is rotated to the right, as indicated by the arrow head, the wire XB moves down during the first half of the revolution. According to Fleming's Rule, the current would be directed from B to X. The wire YA would move up during the first half of the revolution and the current flow from A to Y. As the result of the first half of the revolution, the current would flow in the direction AYBX.

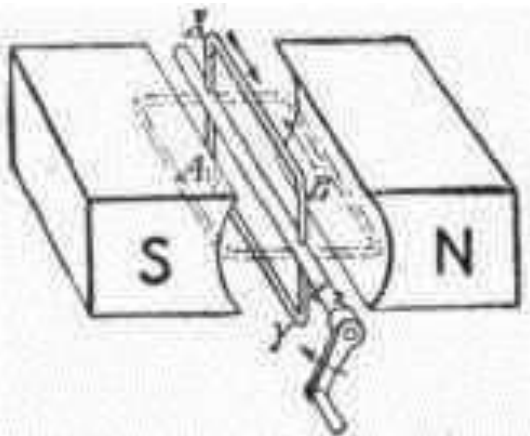


Fig. 1: Magnetic field showing loop of wire rotating between the north (N) and south (S) poles of a magnet.

Repeat the reasoning for the second half of the revolution. Notice that for every complete revolution, the current reverses its direction twice. It is accordingly called alternating current. As the strength of the current depends upon the number of lines of force cut, so the induced electromotive force starts at zero, goes to a maximum, and then back to zero in the first half-turn. That is, the induced

electromotive force reaches its maximum when the loop is in a horizontal position because it cuts the most lines of force at this position. It cuts the least number of lines of force at the beginning and at the end of each half-vertical revolution.

II. WORKING

The system consists of Bevel gear arrangement which is made to rotate dynamo. The basic step is connecting of larger sized gear to the wheel. The bevel gear arrangement is made in the ratio 1:3 (i.e.) for one rotation in wheel, there are 3 rotations in a dynamo. Therefore, rotations in a dynamo are 3 times the rotation in wheel. The smaller sized gear is attached to a dynamo, which is then connected to the storage to store the power generated.

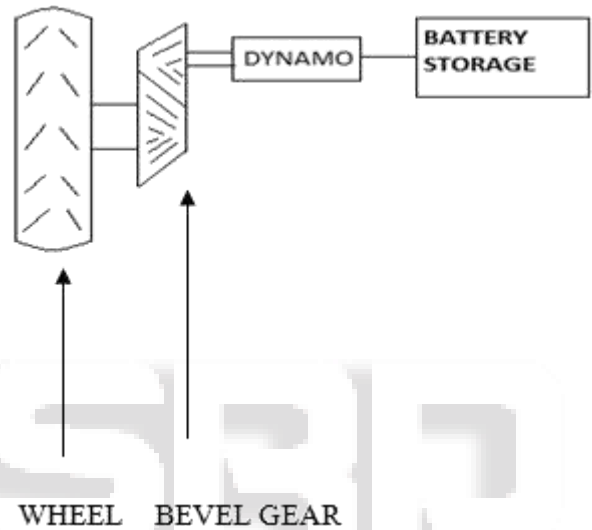


Fig. 2: Block diagram of working of dynamo

Bevel gear arrangement for production of power
Bevel gears are designed in the ratio 1:3 (i.e.)for one rotation of wheel there are three rotations produced in the dynamo.

Large sized gear is attached perpendicular to the shaft of wheel, while another small gear is attached to dynamo. Now dynamo will get large number of rotations because of the size of other gear is large. It is designed in such a way that one rotation of wheel gear produced three rotations in dynamo. Thus large amount of current is produced.

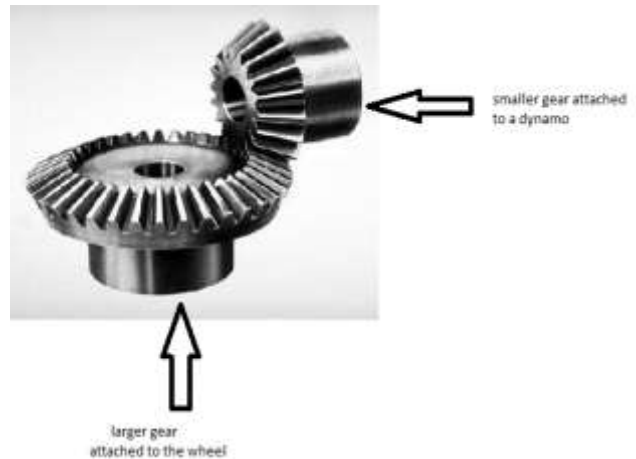


Fig. 3: Bevel gear arrangement for a dynamo

Here we can observe that size of bevel gear vary. This is done to increase number of rotations in dynamo. For one rotation in wheel, it produces three rotations in a dynamo. There is increase in power production. This is applied for all the applications.

A. Various speeds obtained from different applications:

1) Bicycle:

A bicycle runs at an average speed of 20-25 km/hr depending upon the person driving it. As manual pedalling is to be applied in a bicycle, it runs at low speeds. It produces less power which can be used for small applications.

2) Cycling machine at gym

Cycling machines are operated at an average speed of 15-20 km/hr which is used by people for fitness purposes. They are similar to a bicycle in terms of power generation.

3) Automobiles

Automobiles run at very high speeds averaging between 50-60 km/hr. They produce high power which could be used for charging the batteries that can be used for electrical purposes in the automobiles.

III. CALCULATION

A. Calculation of RPM from the speed of the vehicle:

1) Bicycle

Let us assume a bicycle wheel of radius 170 mm running at a speed 20km/hr

$$v = r * RPM * 0.10472$$

$$RPM = \frac{v}{r} * 0.10472$$

Radius, r = 0.17 m

Linear velocity, v = 5.5556 m/s

Where,

v: Linear velocity, in m/s

r: Radius, in meter

RPM: revolutions per minute

$$RPM = \frac{5.5556}{0.17} * 0.10472$$

$$RPM = 312.06 \text{ rpm}$$

since bevel gear produces revolutions in the ratio 1:3

$$\text{actual RPM} = 3 * RPM$$

$$\text{ACTUAL RPM} = 3 * 312.06$$

$$= 936.18 \text{ rpm}$$

1) automobiles

Let us assume a bike wheel of radius 200 mm running at a speed 60km/hr

$$v = r * RPM * 0.10472$$

$$RPM = \frac{v}{r} * 0.10472$$

Radius, r = 0.2 m

Linear velocity, v = 16.6667 m/s

Where,

V: Linear velocity, in m/s

r: Radius, in meter

RPM: revolutions per minute

$$RPM = \frac{16.6667}{0.2} * 0.10472$$

$$RPM = 795.77 \text{ rpm}$$

since bevel gear produces revolutions in the ratio 1:3

$$\text{actual RPM} = 3 * RPM$$

$$= 3 * 795.77$$

$$\text{ACTUAL RPM} = 2387.81 \text{ rpm}$$

Calculation of power produced

we know that power is,

$$P = \tau * \omega$$

Where,

P = power generated in W,

τ = torque in Nm,

ω = Angular velocity in rad/s

1) Bicycle

To calculate ω ,

$$\omega = \text{RPM} * \frac{2\pi}{60} \text{ rad/s}$$

$$936.18 * \frac{2\pi}{60}$$

$$\omega = 98.03 \text{ rad/s}$$

Let us consider torque produced as 2 Nm

$$P = 2 * 98.03$$

$$P = 196.06 \text{ W}$$

Depending on the torque values, power changes.

2) Automobiles

To calculate ω ,

$$\omega = \text{RPM} * \frac{2\pi}{60} \text{ rad/s}$$

$$2387.81 * \frac{2\pi}{60}$$

$$\omega = 250.05 \text{ rad/s}$$

Let us consider torque produced as 2 Nm

$$P = 2 * 250.05$$

$$P = 500.1 \text{ W}$$

Depending on the torque values, power changes.

IV. CONCLUSION

This project aims at producing energy from the alternate sources, which are being used in plenty in day to day life. Also, these sources do not require external energy and are just part of regular routine which is followed.

This project does not aim at producing high energies which can completely eliminate electricity problems. However, it is just a small setup which uses the rotational energy which is produced in plenty to generate some amount of power which can still be useful in day to day life.

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