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Generate Electricity While Cycling

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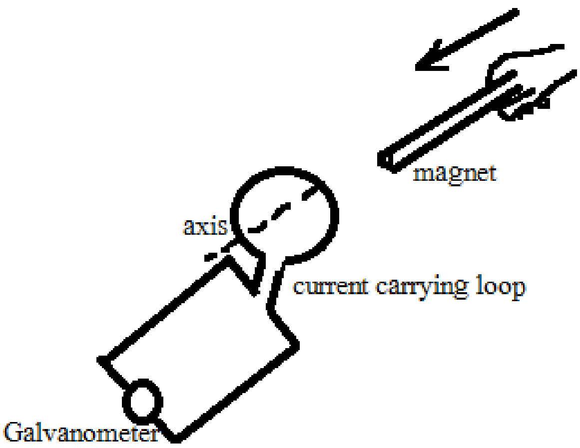
***Abstract*— This paper will propose how to generate electricity while you are cycling. When we are cycling the two wheels rotate. If we convert the rotating motion of wheels into translation motion and we attach a bar magnet. Then the bar magnet will regulate translation motion continuously till the wheels are running. Now, if we attach a conducting current carrying loop near the bar magnet then it will induce an emf into the conducting loop hence current flow. Now we can charge an inverter with this current and emf. And we can easily use this inverter output to glow bulb on a cycle.**

***Index Terms*—About four key words or phrases in alphabetical order, separated by commas.**

I. Electricity Generation Methods



A bar magnet is placed along the axis of a conducting loop containing a galvanometer. There is no current in the loop. If we move the magnet towards the loop there is a deflection in the galvanoleter showing that there is an electric current in the loop. If the magnet is moved away from the loop again there is a current but in opposite direction. The current exists as long as the magnet is moving. Faraday studued the behavior in detail by persorming a number if experiments and discovered the following law of nature :

Faraday's Law : Whenever the flux of magnetic field through the area bounded by a closed conducting loop changes, an emf is produced in a loop. The emf is given by $E = -d\Phi/dt$ where $\Phi = \int B.dS$ is the flux of the magnetic field through the area.

Direction of Induced Current (Lenz's Law) : The direction of the induced current is such that it opposes the change that has induced it.

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The Origin of Induced EMF : The flux $\int B.dS$ can be changed by

1. Keeping the magnetic field constant as time passes and moving whole or part of the loop.
2. Keeping the loop at rest and changing the magnetic field.
3. Combination of (a) and (b), that is, by moving the loop(partly or wholely) as well as by changing the field.

We will adopt method (b) here which is called INDUCED ELECTRIC FIELD.

Induced Electric Field : Consider a conducting loop placed at rest in a magnetic field B. Suppose, the field is constant till t = 0 and then changes with time. An induced current starts in the loop at t=0.

The free electrons were at rest till t=0 (we are not interested in the random motion of the electrons). The magnetic field cannot exert force on electrons at rest, Thus, the magnetic force cannot start the induced current. The electrons may be forced to move only by an electric field and hence we conclude that an electric field appears at t=0. This electric field produced by the charging magnetic field is nonelectrostatic and nonconservative in nature. We cannot define a potential corresponding to this field. We call it INDUCED ELECTRIC FIELD. The lines of induced electric field are closed curves. There are no starting and terminating points of the field lines.

If E be the induced electric field, the force on a charge q placed in the field is qE. The work done per unit charge as the charge moves through dl is E.dl. The emf developed in the loop is, therefore,

$$E = \int E.dl.$$

Using Faraday's law of induction.

$$E = -d\Phi/dt$$

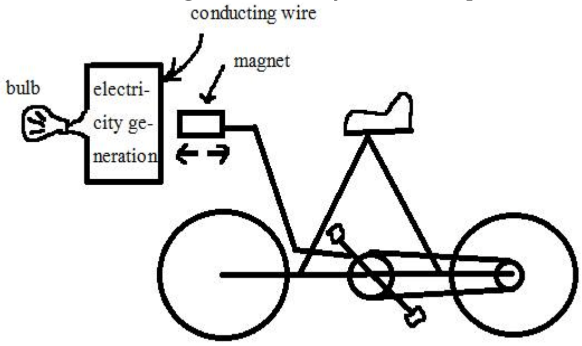
Or, $\int E.dl = -d\Phi/dt.$

The presence of a conducting loop is not necessary to have an induced electric field. As long as B keeps changing, the induced electric field is present. If a loop is there, the free electrons start drifting and consequently an induced current results.

II. System Description

The bicycle wheels and pedal will be attached to bar magnets. Beside the magnet there will be closed current carrying loop. When the wheels and pedals rotate during cycling the rotational motion will be converted to translation motion and hence the bar magnet will be translating to and fro near the current carrying loop. As there is changing flux due to movement of the magnet an EMF will be induced in the current carrying loop as per Faraday's law of induction. And hence the electricity is generated in this way.

Please see the image below for system description :



Fir.2 Generate Electricity while Cycling

III. Property of Electricity

It is well known that one of the subatomic particles of an atom is the electron. Atoms can and usually do have a number of electrons circling its nucleus. The electrons carry a negative electrostatic charge and under certain conditions can move from atom to atom. The direction of movement between atoms is random unless a force causes the electrons to move in one direction. This directional movement of electrons due to some imbalance of force is what is known as electricity.

IV. Merits

1. It is without any external power.
2. It is free of cost.
3. To generate electricity in this method no heavy material required.
4. It is based on fundamental law of generating electricity.
5. Mechanism is easy to understand.

V. Demerits

1. Eddy current loss will be there.
2. Pedaling will be a bit harder.

VI. Eddy Current

Consider a solid plate of metal which enters a region having a magnetic field. Consider a loop drawn on the plate, a par of which is in the field. As the plate moves, the magnetic flux through the area bounded by the loop changes and hence a current is induced, There may be a number of such loops on the plate and hence currents are induced on the surface along a variety of paths. Such currents are called EDDY CURRENTS. The basic idea is that we do not have a definite conducting loop to guide the induced current. The system itself looks for the loops on the surface along which eddy currents are induced. Because of the eddy currents in the metal plate, thermal energy is produced in it. This energy comes at the cost of the kinetic energy of the plae and the plate slows down. This is known as electromagnetic damping.

VII. Self-Induction

When a current is established in a closed conducting loop, it produces a magnetic field. This magnetic field has its flux through the area bounded by the loop. If the current changes with time, the flux through the loop changes and hence an emf is induced in the loop. This process is called SELF-INDUCTION. The name is so chosen because the emf is induced in the loop by changing the curent in the same loop.

The magnetic field at any point due to a current is proportional to the current. The magnetic flux through the area bounded by a current-carrying loop is, therefore proportional to the current. We can write

$$\Phi = Li$$

Where L is a constant depending on the geometrical construction of the loop. This constant is called SELF-INDUCTANCE of the loop. The induced emf E, when the current in the coil changes, is given by

$$E = -d\Phi/dt.$$

Or, $E = -Ldi/dt.$ (from the above equaion)

The SI unit of self-inductance L is webwe/ampere or volt-second/ampere from the above equations. It is given a special name henry and is abbreviated as H.

If we have a coil or a solenoid of N turns, the fluxthrough each turn is $\int B.dS$. If this flux changes, an emf is induced in each turn. The net emf induced between the ends of the coil is the sum of all these. Thus,

$$E = -Nd/dt\int B.dS.$$

VIII. Losses

1. Eddy current loss.
2. Loss due to mechanical coupling.

IX. How to Reduce Losses

1. To reduce electromagnetic damping one can cut slots in the plate. This reduces the possible paths of the eddy current considerably.
2. To reduce mechanical losses proper greese should be used and ball-bearings should be polished properly.

References

[1] Concepts of Physics 2 by H.C. Verma.

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