

Generation of Electricity from Tires using Faraday's Law

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Abstract

The main purpose of this paper is to generate electricity from the normal rolling motion of the tires. We are proposing a model of tire that consists of a circular pipe wound with copper coil on the outer surface of the pipe. An N-52 powerful magnet is placed which is free to move inside the pipe. Faraday's law of electromagnetic induction states that when the magnetic flux linking a circuit changes, an electromotive force (emf) is induced in the circuit proportional to the rate of change of the flux linkage. If there is any change in relative motion of the tire and the magnet due to sudden speed changes an induced emf will be produced in the coil. The maximum voltage will be produced if the tire stops suddenly. As the magnet inside the circular pipe will keep on moving due to inertia. The emf generated is stored in a battery that can be used as a secondary source of energy for the vehicle.

Keywords: Faraday's Law, Electromotive force, Induced emf, N-52 (Neodymium) magnet, Inertia, Magnetic flux density, Rate of change of magnetic flux, Angular speed

1. Introduction

The tires during its rolling motion loses a certain amount of the energy due to various attributes like rolling resistance, macro deformations of the tires material, material hysteresis and slippage friction. To recompense these energy losses we are trying to establish a new setup for the tires. According to our setup, the outer diameter of the tires will be covered with circular pipe. The pipe should be wound with a copper coil. A cylindrical Neodymium-52 magnet is placed inside the pipe. This magnet is free to move inside the coil. If there is any change in between the motion of the tire and the magnet due to sudden speed changes an induced emf will be produced in the coil. This is based on Faraday's law which states that when the magnetic flux linking a circuit changes, an emf is induced in the circuit which is directly proportional to the rate of change of the flux linkage. The induced emf is also directly proportional to the size of the magnet; the bigger the magnet the more power will be generated. The emf is also directly proportional to the number of turns in the coil. The power generated is stored in a primary battery. This stored energy can be used to run small equipments in the system.

2. Abbreviations

V	Volts
cm	Centimeter
emf	Electromotive force

A	Area of the coil
N	Number of turns in the coil
B	Magnetic flux density
$\frac{d(BA)}{dt}$	Rate of change of magnetic flux
ω	Angular speed

3. Working Principle

The sudden changes in the relative speed of tire and the magnet will cause the magnetic flux linkage of the coil to change and an induced emf will be produced. The produced electrical energy can be stored by the means of a battery. Faraday's law of electromagnetic induction states that when the magnetic flux linking a circuit changes, an electromotive force (emf) is induced in the circuit proportional to the rate of change of the flux linkage.

4. Construction and Working

The experimental setup consists of a circular hollow pipe which is wound by a copper coil. Inside the pipe a strong N-52 magnet is placed which is free to move inside the pipe. Whenever the brakes are applied or the sudden fluctuations in the tires occurs, then due to inertia the magnet inside the pipe keeps moving with the initial velocity of car. This causes change in the magnetic flux through the coils around the pipes. Hence an induced emf which is directly proportional to the rate of change of magnetic flux of the coil is generated.

5. Formulae

According to Faraday's law the induced emf can be calculated by the formulae: [3]

$$\text{Emf} = N \frac{d(BA)}{dt}$$

Where,

- N = number of turns in the coil
- B = magnetic field (or magnetic flux density)
- A = area of the coil used around the circular pipe.
- A = Area of the coil = πr^2**

Since the coils are connected in series, the resultant voltage of the two coils wound exteriorly around the circular pipe is given by:

$$V_{\text{RESULTANT}} = V_1 + V_2$$

6. Calculation

If brake is applied the tire stops suddenly but the magnet inside keeps on moving due to inertia and then slows down to rest.

To find the total induced voltage generated by our tires setup using the Faraday's law we make certain assumptions based on research:

- Average car speed : 40km/hr
- Taking diameter of the tire 1.068 m, the Revolutions per minute (rpm) of the car: 198.6 rpm.

Hence in one second the car makes:

$$\frac{198.6}{60} \text{ Rotations}$$

$$= 3.3116 \text{ approximately}$$

- Magnetic field strength of N-52 magnet : 0.7734 Tesla [8] [9]
- The cross sectional diameter of the coil : 10 cm
- The total number of turns in the coil : 500

$$\text{Area of the coil} = \pi r^2$$

$$= 3.14 \times (0.1)^2$$

$$= 0.0314 \text{ m}^2$$

The induced emf based on Faraday's law is given by:

$$\text{Emf} = N \frac{d(BA)}{dt}$$

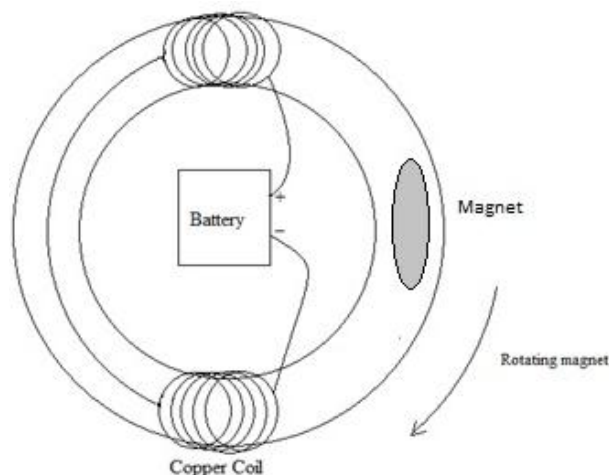
$$\text{Where } \frac{d(BA)}{dt} = BA\omega$$

Assuming that the quarter number of coils near to the magnet at any instant get considerable change in flux,

$$\begin{aligned} \text{Emf} &= NBA\omega \\ &= 125 \times 0.7734 \times 0.0314 \times 20.8052 \\ &= 63.1562 \text{ V} \end{aligned}$$

Hence **63.1562 Volts** is the maximum voltage produced by a tire of a car moving at a speed of 40km/hr when stopped suddenly.

7. Schematics of Setup



8. Advantages and Application

The experimental setup proposed for the tires has various positive aspects and can be applied in various ways to improve the efficiency and performance of the car:

- This setup can be used in any kind of tires.
- This setup is cheap, simple and easy to build.
- The proposed model of the tires based on the Faraday's law is enhancing the energy efficiency of the tires.
- The stored energy can be used as a secondary source of power for vehicles.

Conclusion

The proposed modified model can produce a considerable amount of energy and easy to build. The emf generated is stored in the primary battery which on being completely charged later can be used as secondary power source. The given design of the tires has also derived to improve the energy efficiency of the tires and improve the car performance on the whole.

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