Patent Application: Maxle Generator

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1. Petition

A. Title of Patent

Maxle Generator

B. Name and Address

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C. Statement of Entitlement

The applicant is entitled to apply for a patent and the applicant is the sole inventor of the subject matter.

2. Inventor Information

A. Name

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B. Address

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3. Abstract

The Maxle generator integrates an electric generator into the axle of a vehicle to convert kinetic energy from vehicle motion into electrical energy using electromagnetic induction. The generator comprises coils wound around the axle, high-performance neodymium magnets, and a cooling system using dielectric fluid. The generated electricity can be stored in a battery pack and used to power vehicle systems, enhancing overall energy efficiency. This

filing introduces significant improvements over the previous 2021 filing, particularly with the addition of an advanced cooling system, ensuring greater efficiency and reliability.

4. Claims

1. The axle of any ground vehicle may serve as a template which, through its rotation while moving, can be fitted with a modification to allow the rotational energy to be captured and applied to the vehicle's motion and other power needs.

2. The modification requires little to no drag force to offset the collection of energy and hence, in the balance, is a net green producer of energy.

3. The use of a nonconducting sleeve over an axle will prevent shorting in the armature or magnet to be fitted along the metal of the axle itself.

4. Permanent magnets fitted into the axle housing - north and south alternatively on each side of the axle - create a field which the rotating axle, when fitted with wires along its length, moves through and generates a current in conjunction with.

5. The current is generated using a brushless system where magnets are wrapped around the axle length and receiving coils are placed in the axle housing.

6. An advanced liquid cooling system is integrated within the axle structure, ensuring efficient heat dissipation and maintaining optimal performance.

7. The application of this magnetic axle or 'Maxle' to electric vehicle design will allow extended travel between charges.

5. Description

Theoretical Foundations

The Maxle generator operates on the principles of electromagnetic induction as described by Faraday's Law of Induction. When a conductor moves through a magnetic field, a voltage is induced across the conductor, generating an electric current.

Faraday's Law states:

$$\mathcal{E} = -N\frac{d\Phi}{dt} \tag{1}$$

where:

- $\mathcal{E}$ is the induced EMF,
- N is the number of turns in the coil,
- Φ is the magnetic flux.

The magnetic flux (Φ) is given by:

$$\Phi = B \cdot A \cdot \cos(\theta) \tag{2}$$

where:

- B is the magnetic field strength,
- A is the area of the coil,
- θ is the angle between the magnetic field and the normal to the coil.

Design Considerations

The design of the Maxle generator involves several critical components, including the axle, coils, magnets, and cooling systems. Each component is optimized to maximize efficiency and ensure practical implementation within a vehicle.

Axle and Coil Design

The axle serves as the structural foundation, supporting the coils and magnets. Multi-strand Litz wire is used for the coils to reduce skin effect and proximity effect losses, improving overall efficiency.

- **Axle Diameter**: 60 mm
- **Axle Length**: 1.2 meters
- **Number of Turns**: 200
- **Wire Diameter**: 0.1 mm (multi-strand Litz wire)
- **Coil Length**: 100 meters

Magnetic Components

High-performance neodymium magnets are used to create the magnetic field required for induction. These magnets are placed evenly around the axle.

- **Magnet Dimensions**: 10 mm thick, covering the axle circumference
- **Magnetic Field Strength**: 1.4 Tesla

Cooling System

Effective cooling is essential for maintaining the performance and longevity of the Maxle generator. A liquid cooling system using dielectric fluid is proposed to manage the heat generated during operation. This advanced cooling system distinguishes this filing from the previous 2021 filing, addressing the inadequacies of the original design which lacked efficient heat dissipation mechanisms.

- **Cooling Channels**: Integrated within the axle structure
- **Dielectric Fluid**: Examples include 3M Novec or mineral oil
- **Pump and Reservoir**: Circulates the coolant through the system

Electrical System Integration

A brushless DC (BLDC) motor is used to convert the generated AC to DC, eliminating the need for a separate rectifier. The inverter/rectifier system ensures efficient power conversion and integration with the vehicle's electrical system.

- **BLDC Motor**: Integrated into the axle
- **Inverter/Rectifier**: Manages AC to DC conversion
- **Battery Pack**: Stores the generated electricity

Practical Implementation

The practical implementation of the Maxle generator in a vehicle involves addressing several key aspects, including the impact on vehicle weight, fuel efficiency, and maintenance requirements.

Impact on Vehicle Weight

The total added weight of the Maxle generator components is approximately 26.5 kg. This represents a 1.77% increase in the overall weight of a typical 1,500 kg passenger vehicle. The added weight is relatively small and should have a minimal impact on vehicle performance and handling.

Impact on Fuel Efficiency

To evaluate the impact on fuel efficiency, we consider the relationship between vehicle weight and fuel consumption. The added weight of 26.5 kg is expected to result in a 0.027% decrease in fuel efficiency. For a vehicle with a baseline fuel efficiency of 8 liters per 100 km, the new fuel efficiency would be approximately 8.00216 liters per 100 km, a negligible difference.

Cost and Maintenance

The estimated initial cost of the Maxle generator is $2,225, including materials, manufacturing, and assembly. The annual maintenance cost is estimated to be $300, covering cooling system maintenance, electrical system checks, and component inspections.

Mathematical Proof and Calculations

EMF Calculation

The EMF induced in the coils is calculated using Faraday's Law:

$$\mathcal{E} = N \cdot \Delta\Phi \cdot f \tag{3}$$

where:

- $N = 200$ turns,
- $\Delta\Phi = 0.0158\,\text{Wb}$,
- $f = 300\,\text{Hz}$.

$$\mathcal{E} = 200 \cdot 0.0158 \cdot 300 \approx 948\,\text{V} \tag{4}$$

Current Calculation

The current induced in the coils is given by:

$$I = \frac{\mathcal{E}}{R} \tag{5}$$

where $R = 0.0214\,\Omega$.

To determine a realistic current limit, we calculate the current based on the heat dissipation capacity of the wire. Assuming a safe current density for copper wire is approximately 6 A/mm^2, and using a wire diameter of 0.1 mm, the cross-sectional area A of a single strand is:

$$A = \pi \left(\frac{0.1}{2}\right)^2 \approx 0.00785\,\text{mm}^2 \tag{6}$$

For multi-strand Litz wire, with 200 strands:

$$A_{total} = 200 \times 0.00785 \approx 1.57\,\text{mm}^2 \tag{7}$$

Given the safe current density of 6 A/mm^2:

$$I_{max} = 6 \times 1.57 \approx 9.42\,\text{A} \tag{8}$$

We will use this realistic current limit in our calculations.

Copper Losses

The copper losses are calculated as:

$$P_{copper} = I^2 \times R \tag{9}$$

$$P_{copper} = 9.42^2 \times 0.0214 \approx 1.9\,\text{Watts} \tag{10}$$

Total Losses

The total losses include copper losses, hysteresis losses, eddy current losses, and other minor losses:

$$P_{total\_loss} = 0.01 + 0.15 + 1.9 + 2,250 + 7 + 8.5 + 40 + 0.9 \approx 2,308.46\,\text{Watts} \tag{11}$$

Net Electrical Power Output

The net electrical power output is given by:

$$P_{elec_{net}} = \mathcal{E} \times I - P_{total\_loss} \tag{12}$$

$$P_{elec_{net}} = 948 \times 9.42 - 2,308.46 \approx 6,642.96\,\text{Watts} \tag{13}$$

Efficiency Calculation

The efficiency of the Maxle generator is calculated as:

$$\eta = \frac{P_{elec_{net}}}{P_{mech}} \times 100 \tag{14}$$

where $P_{mech} = 15,000\,\text{Watts}$.

$$\eta = \frac{6,642.96}{15,000} \times 100 \approx 44.29\% \tag{15}$$

6. Drawings

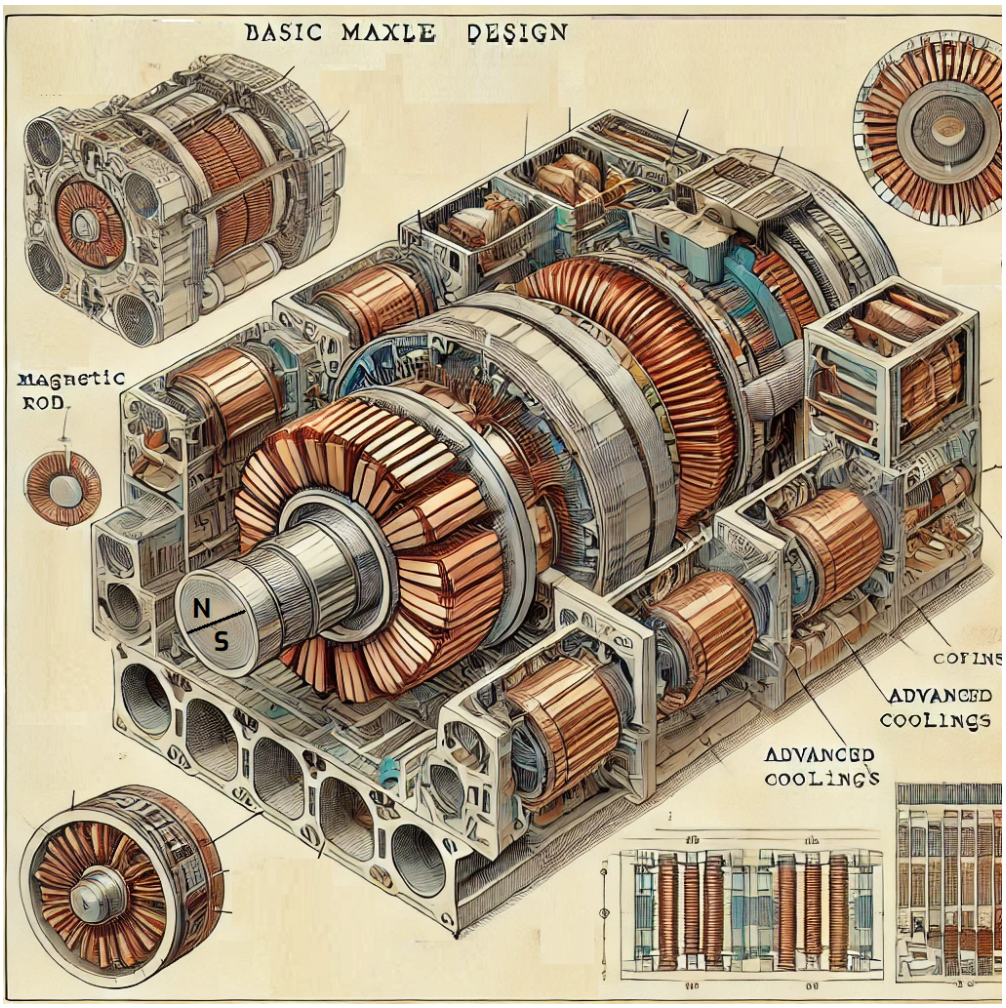

Figure 1: Detailed diagram of the Maxle generator

7. Small Entity Declaration

The applicant, Paul Hallelujah, believes that in accordance with the patent rules, he is entitled to pay fees at the small entity level in respect of this application and in respect of any patent issued on the basis of this application.

Signed: _____

Paul Hallelujah
Calgary, AB