Provisional Patent Application (PPA)

Title: In-Motion Dual Electromagnetic and Plasmonic Energy Harvesting and Discharge System for Vehicular Power Generation and Distribution

1. Technical Field

This invention relates to mobile energy systems, specifically a dual-mode energy harvesting apparatus embedded within vehicle tires that generates and stores electricity using electromagnetic induction and plasmonic resonance while the vehicle is in motion.

2. Background

Electric and hybrid vehicles rely primarily on static charging infrastructure and regenerative braking to replenish battery power. These methods are constrained by downtime and mechanical limitations, particularly on highways where braking energy is minimal. A need exists for a system that enables energy generation during uninterrupted vehicle motion, reducing dependency on external charging and extending operational range.

3. Summary of the Invention

This invention comprises a multi-layered tire-integrated energy harvesting system that simultaneously utilizes:

- Electromagnetic resonance via piezoelectric and magnetic interactions
- Plasmonic resonance via nanostructured conductive materials

Each tire is embedded with a slip ring array that emits phase-synchronized frequencies into the internal layered structure. The system converts road-induced mechanical energy and rotational momentum into modulated frequency waves, which interact with nano-tunneling architectures to excite electrons and extract energy.

4. Detailed Description

a. Slip Ring Modulation Array:

- 40 slip rings per tire (160 for 4-wheel, 720 for 18-wheeler)

- Emit targeted frequencies ranging from kHz to THz

- Synchronize with tire speed and road condition sensors

b. Layered Composite System (Optimized):

1. Graphene-Based Plasmonic Layer:

  - Resonates at 10-100 THz

  - Contains femtosecond-patterned nano-tunnels to maximize surface plasmon excitation

  - Optimized for high conductivity and charge mobility through ultrathin atomic lattice patterning

2. MXene-PVDF Piezoelectric Layer:

  - Operates at 20-200 kHz for efficient vibration-to-voltage conversion

  - Tuned to mechanical resonance frequency bands of tire-road interaction

  - Nano-tunnels reinforce charge propagation and mechanical strain response

3. SiC-GNP-Fe_4O_4 Ferrite Layer:

  - Thermally stable, high magnetic permeability

  - Supports electromagnetic induction and acts as a waveguide for EM fields

  - Spiral nano-tunnels direct electron flow and stabilize discharge dynamics

c. Nano-Tunneling Architecture:

- Vertically aligned, spiraled, and density-calibrated tunnels for each layer

- Tunnel geometry varies per material: larger diameters in piezo layers, narrower plasmonic tunnels for quantum confinement

- Aligned to form uninterrupted multi-path channels for dual-mode resonance propagation

d. Frequency Base Modulation Tier:

- Tri-phasic frequency modulation system

- Generates waveform transitions between EM and plasmonic excitation states

- Coordinates amplitude and phase to match rotational velocity and traction feedback

5. Energy Storage and Discharge

Energy harvested is routed through:

- Onboard supercapacitor banks for fast storage and discharge

- Integrated battery systems for sustained propulsion

- Vehicle-to-Grid (V2G) ports for community or commercial energy export

6. Use Case and Yield Projections

EV/Hybrid Vehicle (4 wheels):

- 160 Slip Rings

- 300-mile drive

- Yield: 120-200 kWh

Commercial 18-Wheeler:

- 720 Slip Rings

- 1160-mile trip

- Yield: up to 133.63 kWh

Discharge rate: Up to 7.5 kWh/hour under optimized load and tuning.

7. Benefits and Applications

- Reduces need for grid charging

- Enables real-time energy collection on highways

- Provides energy resale opportunities via V2G networks

- Extends EV range without structural redesign

8. Claims (Expanded and Analyzed)

1. A vehicular tire-based energy harvesting system comprising a multilayered composite architecture that converts electromagnetic and plasmonic resonance into electrical energy during motion.

2. The system of claim 1, wherein each tire comprises a 40-point slip ring array emitting synchronized modulation frequencies.

3. The system of claim 1, wherein said composite layers include graphene-based plasmonic waveguides, MXene-piezoelectric materials, and ferrite conductive substrates.

4. The system of claim 1, further comprising vertically aligned nano-tunneling structures patterned for phase coherence and energy redirection.

5. The system of claim 1, wherein the generated energy is routed to a supercapacitor, battery, or grid discharge module.

6. The system of claim 3, wherein the graphene layer supports plasmonic resonance between 10-100 THz and includes femtosecond-laser patterned nano-channels.

7. The system of claim 3, wherein the MXene-PVDF layer functions as a vibration-to-electrical transducer in the 20-200 kHz range.

8. The system of claim 3, wherein the ferrite layer exhibits high electromagnetic permeability and thermal conductivity.

9. The system of claim 4, wherein nano-tunnels are spiral-shaped and geometrically tuned to each layer's density and dielectric profile.

10. The system of claim 1, further comprising a multi-phase frequency modulator coordinating amplitude and wave shape for optimal energy transition.

11. The system of claim 10, wherein said modulator synchronizes with wheel rotation data and tire-road traction analytics.

12. The system of claim 1, wherein tunnel alignment forms a continuous waveguide from outer excitation to energy collection point.

13. The system of claim 1, wherein energy harvested is prioritized to onboard storage before external discharge.

14. The system of claim 1, further comprising a vehicle-to-grid interface with smart control logic.

15. The system of claim 1, wherein electromagnetic and plasmonic fields are dynamically tuned to excite surface and volumetric charge zones for maximal harvesting efficiency.

9. Conclusion

This invention allows vehicles to become continuous energy harvesters by integrating nano-engineered materials and frequency modulation systems directly into their tires. The combination of plasmonic and electromagnetic resonance opens new avenues for sustainable, mobile energy infrastructure. Each layer in the system is optimized for its distinct role-plasmonic amplification, piezoelectric conversion, or EM conductivity-yet unified through a shared tunnel matrix and modulation system that maximizes energy flow, retention, and redistribution.

(End of Provisional Patent Application)