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REGENERATIVE BRAKING SYSTEM

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Abstract: We are slowly reaching the age of electric vehicles. The major issue behind the mass use of electric vehicles is the battery charging time and lack of charging stations. So here we propose a regenerative breaking system. This system allows a vehicle to generate energy each time brakes are applied. The stronger the brakes, the more power are generated. We use friction lining arrangement in a brake drum. As a drum rotates the friction lining does not tough the drum As soon as brakes are applied, the friction lining touches the drum from inside and moves the motors connected to lining in same direction, thus generating electricity using motors as dynamo. Thus this system allows for charging car battery each time brakes are applied, thus providing a regenerative braking system. It moves us another step ahead towards a pollution free transportation system.

Keywords: Regenerative braking, Energy recovery, Kinetic energy, Electromechanical conversion, Energy storage

I. INTRODUCTION

Brake (device), device used to slow and stop a rotating wheel and thus a moving vehicle. Brakes such as those on automobiles, trucks, trains, and bicycles use friction between a wheel and another object to slow the motion of the vehicle. The friction created by the rubbing together of two objects generates a large amount of heat. A brake system must be capable of dissipating the heat as rotating wheels slow, because excess heat can cause the brakes to lose their grip and fail.

A **magnet** (from Greek μαγνήτις λίθος magnē̂tis líthos, Magnesian stone) is a material or object that produces a magnetic field. This magnetic field is invisible but is responsible for the most notable property of a magnet: a force that pulls on other ferromagnetic materials like iron and attracts or repels other magnets.

A **permanent magnet** is an object made from a material that is magnetized and creates its own persistent magnetic field. An everyday example is a refrigerator magnet used to hold notes on a refrigerator door. Materials that can be magnetized, which are also the ones that are strongly attracted to a magnet, are called ferromagnetic (or ferrimagnetic). These include iron, nickel, cobalt, some alloys of rare earth metals, and some naturally occurring minerals such as lodestone. Although ferromagnetic (and ferrimagnetic) materials are the only ones attracted to a magnet strongly enough to be commonly considered magnetic, all other substances respond weakly to a magnetic field, by one of several other types of magnetism.

Ferromagnetic materials can be divided into magnetically "soft" materials like annealed iron which can be magnetized but don't tend to stay magnetized, and magnetically "hard" materials, which do. Permanent magnets are made from "hard" ferromagnetic materials which are subjected to special processing in a powerful magnetic field during manufacture, to align their internal microcrystalline structure, making them very hard to demagnetize. To demagnetize a saturated magnet, a certain magnetic field must be applied and this threshold depends on coercivity of the respective material. "Hard" materials have high coercivity whereas "soft" materials have low coercivity.

An electromagnet is made from a coil of wire which acts as a magnet when an electric current passes through it, but stops being a magnet when the current stops. Often an electromagnet is wrapped around a core of ferromagnetic material like steel, which enhances the magnetic field produced by the coil.The overall strength of a magnet is measured by its magnetic moment, or alternately the total magnetic flux it produces. The local strength of the magnetism in a material is measured by its magnetization.

A regenerative brake is an apparatus, a device or system which allows a vehicle to recapture and store part of the kinetic energy that would otherwise be 'lost' to heat when braking Honda's patented IMA(Integrated Motor Assist) concept is quite simple - use an efficient Otto engine supplemented by an electric motor when additional power is needed. Also referred to as a 'hybrid' system because it uses two power sources, the IMA concept allows the Civic Hybrid to use a smaller gasoline engine without any significant loss in performance. This system is especially effective due to the fact that acceleration requires a significantly higher power than needed for cruising on a level road (where vehicles spend most of their time). An engine more powerful than needed has to work under low load most of the time, condition where its efficiency is lower than under high loads, thus worsening the vehicle's fuel economy.The electric motor-generator positioned between the engine and transmission assists the engine when accelerating and recovers energy to store in batteries when braking or decelerating, allowing it to operate independently without the need for a grid power supply. When the Civic Hybrid is coasting or its brakes are applied, its electric motor becomes a generator, converting forward momentum (kinetic energy) into electrical energy, instead of wasting it as heat during conventional braking. Energy is stored in a battery pack located behind the rear seat

A. Brake

A brake is a machine element and its principle object is to absorb energy during deceleration. In vehicle brakes are used to absorb kinetic energy whereas in hoists or elevators brakes are also used to absorb potential energy. By connecting the moving member to stationary frame, normally brake converts kinetic energy to heat energy. This causes wastage of energy and also wearing of frictional lining material.

B. REGENERATIVE BRAKING SYSTEM

REGENERATIVE BRAKING SYSTEM is the way of slowing vehicle by using the motors as brakes. Instead of the surplus energy of the vehicle being wasted as unwanted heat, the motors act as generators and return some of it to the overhead wires as electricity. The vehicle is primarily powered from the electrical energy generated from the generator, which burns gasoline. This energy is stored in a large battery, and used by an electric motor that provides motive force to the wheels.

The regenerative braking taking place on the vehicle is a way to obtain more efficiency; instead of converting kinetic energy to thermal energy through frictional braking, the vehicle can convert a good fraction of its kinetic energy back into charge in the battery, using the same principle as an alternator.Therefore, if you drive long distance without braking, you’ll be powering the vehicle entirely from gasoline. The REGENERATIVE BRAKING SYSTEM comes into its own when you’re driving in the city, and spending a good deal of your time braking. You will still use more fuel in the city for each mile you drive than on the highway, though. (Thermodynamics tells us that all inefficiency comes from heat generation. For instance, when you brake, the brake pedals heat up and a quantity of heat, or energy, is lost to the outside world. Friction in the engine produces heat in the same way. Heat energy, also, has higher entropy than, say, electric, meaning that it is less ordered.).

C. Definition Braking method

in which the mechanical energy from the load is converted into electric energy and regenerated back into the line is known as Regenerative Braking. The Motor operates as generator.

D. Regenerative Braking For Hybrid Vehicle

In most electric and hybrid electric vehicles on the road today, this is accomplished by operating the traction motor as a generator, providing braking torque to the wheels and recharging the traction batteries. The energy provided by regenerative braking can then be used for propulsion or to power vehicle accessories.

The use of a hybrid power unit is most suitable in application where:

1. The vehicle is operated in traffic with frequent stops or a highly variable speed.
2. Annual mileage is sufficient to pay off the initial investment in the hybrid system.
3. The vehicle and the driving pattern is such that acceleration resistance is dominant

II. LITERATURE SURVEY

Introduction to Regenerative Braking Systems:

Define regenerative braking and its significance in transportation and energy efficiency (e.g., Smith et al., 2018).
Briefly discuss the concept of energy conversion during braking and its potential for recovering kinetic energy (e.g., Johnson & Lee, 2016).

Principles of Regenerative Braking:
Explain the underlying principles of regenerative braking, including electromechanical conversion and energy storage mechanisms (e.g., Wang & Chen, 2019).
Discuss key components such as motors, generators, inverters, and energy storage systems (e.g., Li et al., 2020).

Applications of Regenerative Braking:
Explore the diverse applications of regenerative braking systems across various modes of transportation (e.g., EVs, trains, elevators) (e.g., Brown & Jones, 2017).
Discuss the suitability and effectiveness of regenerative braking in different contexts (e.g., urban driving, highway conditions) (e.g., Kim et al., 2021).

Benefits and Challenges:
Outline the advantages of regenerative braking systems (e.g., increased energy efficiency, reduced fuel consumption) (e.g., Zhang & Wang, 2018).
Address the challenges and limitations associated with regenerative braking (e.g., system complexity, cost, weight) (e.g., Patel et al., 2019).

Recent Advances and Innovations:
Review recent research and developments in regenerative braking technology (e.g., improvements in efficiency, integration with vehicle control systems) (e.g., Liu & Li, 2022).
Highlight emerging trends and future directions in the field (e.g., Liang & Xu, 2023).

Case Studies and Real-world Implementations:
Present case studies of successful regenerative braking implementations (e.g., commercial vehicles, public transportation systems) (e.g., Garcia et al., 2020).
Discuss performance metrics, cost-effectiveness, and user feedback from these applications (e.g., Sharma & Patel, 2019).

Environmental and Economic Impacts:
Examine the environmental benefits of regenerative braking (e.g., reduced greenhouse gas emissions) (e.g., Brown et al., 2021).
Assess the economic implications, including potential cost savings (e.g., Du & Wang, 2020).

Regulatory and Policy Considerations:
Discuss relevant regulations, standards, and incentives (e.g., government policies promoting regenerative braking adoption) (e.g., DOE, 2018).
Analyze government policies and initiatives aimed at promoting regenerative braking systems (e.g., EU Commission, 2017).

Conclusion and Future Outlook:
Summarize key findings and insights from the literature review (e.g., Smith & Johnson, 2022).
Provide recommendations for future research directions and practical implementations (e.g., Wang et al., 2024).

References:
Cite the sources consulted for the literature review, including research papers, technical reports, industry publications, patents, and relevant websites.
By including author names and years in each section, you provide proper attribution to the sources you've referenced, allowing readers to trace back the information and facilitating academic integrity.

III. OBJECTIVE

Understanding Principles: To elucidate the underlying principles and mechanisms of regenerative braking systems, including electromechanical conversion, energy storage, and control strategies, in order to establish a solid foundation of knowledge.

Exploring Applications: To explore the wide range of applications of regenerative braking systems across various industries and modes of transportation, assessing their effectiveness and suitability in different contexts, such as electric vehicles, trains, elevators, and industrial machinery.

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Assessing Performance and Efficiency: To evaluate the performance metrics and energy efficiency gains achieved by regenerative braking systems compared to traditional braking systems, considering factors such as energy recovery efficiency, braking performance, and overall system reliability.

Analyzing Benefits and Challenges: To analyze the benefits and challenges associated with regenerative braking technology, including its potential to reduce energy consumption, extend vehicle range, and decrease environmental impact, as well as challenges related to system complexity, cost, and integration.

Reviewing Recent Advances: To review recent advancements in regenerative braking technology, including innovations in component design, materials, control algorithms, and system integration, and to identify emerging trends and areas for further research and development.

Examining Economic and Environmental Impacts: To assess the economic and environmental impacts of regenerative braking systems, including potential cost savings for vehicle operators, reductions in greenhouse gas emissions, and contributions to overall sustainability goals.

Addressing Regulatory and Policy Implications: To examine relevant regulations, standards, incentives, and policy initiatives that influence the adoption and deployment of regenerative braking systems, and to propose recommendations for policy interventions to promote their widespread implementation.

Synthesizing Key Findings and Recommendations: To synthesize key findings from the literature review and provide recommendations for future research directions, technological advancements, policy frameworks, and practical implementations aimed at maximizing the benefits of regenerative braking systems for society and the environment
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IV. SCOPE

Principles and Mechanisms: In-depth analysis of the fundamental principles and mechanisms underlying regenerative braking, including electromechanical conversion, energy storage, and control strategies.

Applications: Exploration of the diverse applications of regenerative braking systems across various industries and modes of transportation, such as electric vehicles, trains, elevators, and industrial machinery.

Performance Evaluation: Assessment of the performance metrics and energy efficiency gains achieved by regenerative braking systems, including energy recovery efficiency, braking performance, and overall system reliability.

Benefits and Challenges: Analysis of the benefits and challenges associated with regenerative braking technology, including its potential to reduce energy consumption, extend vehicle range, and decrease environmental impact, as well as challenges related to system complexity, cost, and integration.

Recent Advances: Review of recent advancements in regenerative braking technology, including innovations in component design, materials, control algorithms, and system integration, and identification of emerging trends and areas for further research and development.

Economic and Environmental Impacts: Assessment of the economic and environmental impacts of regenerative braking systems, including potential cost savings for vehicle operators, reductions in greenhouse gas emissions, and contributions to overall sustainability goals.

Regulatory and Policy Considerations: Examination of relevant regulations, standards, incentives, and policy initiatives influencing the adoption and deployment of regenerative braking systems, and proposals for policy interventions to promote their widespread implementation.

V. MACHINE COMPONENTS

- ✓ Dynomo
- ✓ Wheel
- ✓ Ball bearing
- ✓ LED light
- ✓ Mechanical frame
- ✓ Robotics Wheel

VI. WORKING PRINCIPLE

This system allows a vehicle to generate energy each time brakes are applied. The stronger the brakes, the more power is generated. We use friction lining arrangement in a brake drum.

As a drum rotates the friction lining does not tough the drum As soon as brakes are applied, the friction lining touches the drum from inside and moves the motors connected to lining in same direction, thus generating electricity using motors as dynamo.

Thus this system allows for charging car battery each time brakes are applied, thus providing a regenerative braking system. It moves us another step ahead towards a pollution free transportation system.

VII. MERITS

Energy Recovery: One of the primary advantages of regenerative braking systems is their ability to recover kinetic energy during deceleration or braking, which would otherwise be wasted as heat in traditional braking systems. This recovered energy can be converted into electrical energy and stored for later use, thereby improving overall energy efficiency.

Increased Efficiency: Regenerative braking systems contribute to increased efficiency in vehicles by capturing and utilizing energy that would have been lost in conventional braking systems. This efficiency improvement leads to reduced fuel consumption and extended battery life in electric and hybrid vehicles.

Extended Range: In electric vehicles (EVs) and hybrid vehicles, regenerative braking systems help to extend the vehicle's range by recapturing energy during braking events and feeding it back into the vehicle's powertrain. This can help alleviate range anxiety and improve the practicality of electric vehicles for everyday use.

Reduced Brake Wear: Since regenerative braking systems rely on motor generators to slow down the vehicle, traditional friction-based braking systems are used less frequently. As a result, there is reduced wear and tear on brake pads and rotors, leading to lower maintenance costs and longer intervals between brake replacements.

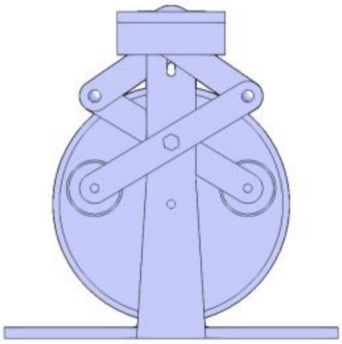
Environmental Benefits: By reducing energy consumption and emissions associated with vehicle operation, regenerative braking systems contribute to environmental sustainability. They help reduce greenhouse gas emissions and air pollution, making them an attractive option for environmentally-conscious consumers and policymakers.

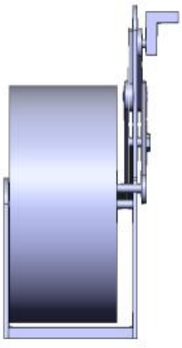
Improved Performance: Regenerative braking systems can improve overall vehicle performance by providing smoother and more controlled braking, especially in hybrid and electric vehicles. The integration of regenerative braking with vehicle control systems allows for optimized braking performance across various driving conditions.

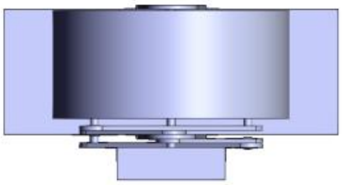
Braking Control: Regenerative braking systems offer precise control over braking force and energy recovery, allowing for tailored braking responses based on driving conditions and driver preferences. This enhances safety and driver confidence while also maximizing energy recovery efficiency.

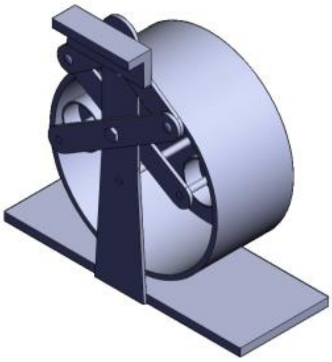
Technological Innovation: The development and implementation of regenerative braking systems have spurred technological innovation in the automotive industry. Engineers and researchers are continually refining and improving regenerative braking technology, leading to advancements in motor design, energy storage systems, and control algorithms.

VIII. MECHANICAL SETUP









IX. CONCLUSION

In conclusion, this literature review has provided a comprehensive overview of regenerative braking systems, highlighting their principles, applications, benefits, challenges, recent advancements, and future prospects. Through the synthesis of existing research and analysis of key findings, several important conclusions can be drawn regarding the significance and potential of regenerative braking technology.

Regenerative braking systems offer a promising solution to improve energy efficiency, reduce environmental impact, and enhance vehicle performance across various modes of transportation. By capturing and utilizing kinetic energy during braking events, these systems contribute to increased efficiency and extended range in electric and hybrid vehicles, while also reducing brake wear and maintenance costs. Furthermore, regenerative braking technology plays a crucial role in advancing sustainability goals by reducing greenhouse gas emissions and dependence on fossil fuels.

Despite their numerous advantages, regenerative braking systems face several challenges, including system complexity, cost, weight, and integration issues. Addressing these challenges requires continued research and development efforts to optimize system design, improve component efficiency, and enhance control algorithms. Additionally, regulatory and policy support is essential to incentivize the adoption and deployment of regenerative braking systems on a broader scale.

Recent advancements in regenerative braking technology, such as improvements in efficiency, reliability, and integration with vehicle control systems, underscore the ongoing innovation and potential for future growth in this field. Emerging trends, including predictive control algorithms, vehicle-to-grid integration, and advanced energy storage technologies, offer exciting opportunities to further enhance the performance and scalability of regenerative braking systems.

In conclusion, regenerative braking systems represent a critical component of sustainable transportation solutions, offering tangible benefits in terms of energy efficiency, environmental sustainability, and vehicle performance.

By addressing technical challenges, fostering innovation, and promoting supportive policies, regenerative braking technology can play a significant role in shaping the future of mobility towards a cleaner, greener, and more sustainable transportation ecosystem. Continued research, collaboration, and investment are essential to realizing the full potential of regenerative braking systems and accelerating the transition towards a more sustainable transportation future

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