International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

REGENERATIVE SHOCK ABSORBERS

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ABSTRACT: Electric vehicles (EVs) have gained popularity as a solution to the fossil fuel crisis and carbon emissions. However, limited range due to battery constraints has been a major obstacle to widespread adoption. Battery management strategies, fast charging, and strategic charging station placement are some of the solutions being explored to address this issue. Another solution is to harness energy from the shock absorbers, which are responsible for filtering vehicle vibrations on rough roads. Research has been conducted since the 1980s on harnessing energy from shock absorbers, and **REGENERATIVE SHOCK ABSORBERS** have been proposed as a way to harvest the kinetic energy dissipated by suspension vibrations. Studies have shown that **REGENERATIVE SHOCK ABSORBERS** can produce up to 400W of power at 100 km/h, and can improve the energy harvesting and ride comfort of regenerative vehicle suspensions. Some studies have used electromagnetic methods to generate electric power, while others have used hydraulic methods. The use of regenerative shock absorbers in EVs is a promising solution that has the potential to significantly extend the range of these vehicles.

KEYWORDS: Regenerative shock absorber; vehicle suspension; vehicle kinetic energy recovery.

1. Introduction:

Electric vehicles are a clean solution to the fossil fuel crisis and CO2 emissions. However, their limited mile range due to battery limitations causes "range anxiety." Solutions include battery management strategies, fast charging, and charging station site selection. Energy harvesting and alternative energy sources may be a better solution. Shock absorbers are a key component in vehicle suspension and energy wasted in them can be harvested. Studies have proposed regenerative shock absorbers to harvest kinetic energy from suspension vibrations. These have potential to improve energy harvesting and ride comfort. Some studies have achieved optimal performance and ride comfort with closed-form solutions for energy regenerative suspensions. Further studies have been conducted on the design and optimization of regenerative shock absorbers. These include linear and rotary electromagnetic methods, hydraulic methods, and rack-and-gears methods. Some of these methods have achieved high efficiency and reliability.

i. Objective:

The main objective of this project is to build a working model of the Regenerative Shock absorber for automotive applications which can generate electricity and act as an additional on board power source to satisfy the increasing need of electricity in EV-vehicles.

▪ To test and determine the optimum working condition for the Regenerative shock absorber to obtain the highest possible efficiency.

▪ The additional objectives of the project are that the working model built has to be compact and can be used for various types of vehicles.

ii. Advantages:

- Improved vehicle efficiency through energy conversion.
- In EVs, regenerative shock absorbers can contribute to extending the vehicle's range by harnessing energy that would otherwise be lost as heat during suspension movement.
- Reduced energy consumption and increased fuel savings.
- Enhanced sustainability by capturing wasted energy.
- Improved ride comfort by damping vibrations.
- Potential for energy storage for supplementary power.
- Versatile integration into various vehicle types.

iii. Disadvantage:

- Complexity of design and integration into existing vehicle systems.
- Dependency on road conditions for optimal energy harvesting performance.
- Limited effectiveness on smooth road surfaces, impacting energy harvesting efficiency.

2. METHODOLOGY:

- **Problem Definition:** Clearly define the objectives of the regenerative shock absorber project, such as increasing vehicle efficiency, reducing energy consumption, or improving ride comfort.
- **Literature Review:** Conduct a thorough review of existing literature, research papers, and patents related to regenerative shock absorbers. This helps in understanding the current state-of-the-art, identifying potential design approaches, and learning from past successes and failures.
- **Conceptual Design:** Generate initial design concepts based on the literature review and the project objectives. Consider factors such as the type of energy harvesting method (e.g., electromagnetic or hydraulic), integration with existing vehicle systems, and compatibility with different vehicle models.
- **Material Selection:** Selected the true material based on model design and criteria.
- **Fabrication:** Fabricate the components of the regenerative shock absorber according to the finalized design.
- **Testing:** Conduct laboratory tests and field trials to validate the performance of the regenerative shock absorber prototype. Measure key parameters such as power generation, energy storage efficiency, and impact on vehicle handling and ride quality.
- **Documentation:** Preparing a report for the project.

3. LITERATURE REVIEW:

- **Peng Zheng:**
  Peng Zheng et al.'s review presented at the 2018 28th International Conference on Automation and Computing in Newcastle Upon Tyne, UK, delves into the research surrounding regenerative shock absorbers. These shock absorbers are a promising area of study due to their potential to harvest and convert energy from vehicle vibrations into usable electricity. The review likely discusses advancements, challenges, and potential applications of regenerative shock absorbers, shedding light on their role in enhancing vehicle efficiency and sustainability. [1].

- **Seema Tiwari**:
  Semma Tiwari et al.'s work, published in the May 2020 issue of the International Journal of Engineering Research and Technology (IJERT) based in Pune, likely focuses on a specific topic within the realm of engineering research and technology. Without further details, it's challenging to provide a precise summary, but the paper likely presents original research findings, technological innovations, or theoretical advancements relevant to the engineering field. [2].

- **Hyanyu Zhau**:
  Huanyu Zhao et al.'s research review, conducted at the College of Instrumentation & Electrical Engineering, Jilin University in Changchun, China in 2020, likely explores the concept of a Vehicle Energy-Regenerative Suspension System. This system likely aims to harness energy from vehicle vibrations during motion and convert it into usable energy, potentially enhancing vehicle efficiency and sustainability. The review likely discusses existing research, technological developments, challenges, and potential applications of such a system, providing insights into its feasibility and effectiveness. [3].

- **Zhanwen Wang:**
  Zhanwen Wang et al.'s research, published in the January 2020 issue of Energy and Built Environment, focuses on the development of a high-efficiency regenerative shock absorber designed for use in range-extended electric vehicles. The shock absorber integrates twin ball screws transmissions, aiming to maximize energy harvesting capabilities from vehicle vibrations. This innovative approach likely enhances the efficiency of regenerative systems in capturing and converting kinetic energy into usable electrical energy, potentially extending the range of electric vehicles while reducing reliance on external charging sources. [4].

- **Andrea Tonoli:**
  Andrea Tonoli et al.'s work, featured in the August 2021 issue of Mechatronics, focuses on rotary regenerative shock absorbers designed for automotive suspensions. These shock absorbers likely employ rotary mechanisms to efficiently harvest energy from vehicle vibrations and convert it into usable electrical energy. The research likely explores advancements in this technology, discussing its potential applications in improving vehicle performance, energy efficiency, and sustainability. This work likely contributes to the ongoing efforts in developing innovative solutions for automotive systems that enhance overall efficiency and reduce environmental impact. [5].

4. WORKING PRINCIPLE:

The working principles of regenerative shock absorbers involve several key components and processes.

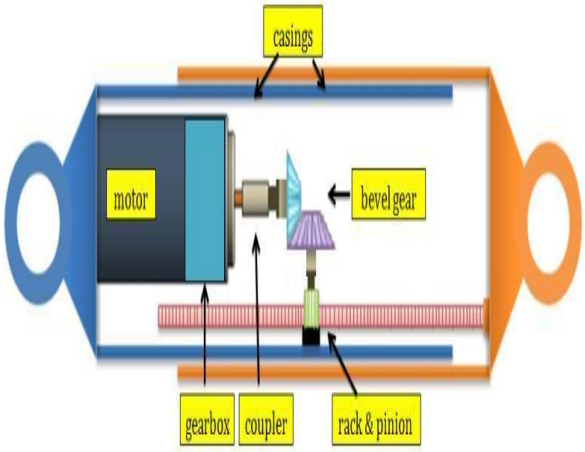


FIG: - **Regenerative shock absorber**

- **Suspension Motion:**

Regenerative shock absorbers are integrated into a vehicle's suspension system, just like conventional shock absorbers. As the vehicle moves over uneven terrain, the suspension system experiences vertical motion due to bumps, potholes, and road imperfections.

- **Kinetic Energy Capture:**

Within the regenerative shock absorber, there is a specialized mechanism for capturing the kinetic energy generated during suspension motion.

- **Energy Utilization:**

The stored electrical energy can be used to power auxiliary systems within the vehicle, recharge the primary battery, or provide additional power for acceleration and propulsion, thereby improving vehicle efficiency.

- **Components and Design:**

These shocks include additional components for energy capture, conversion, and storage, such as generators, hydraulic systems, and electrical connections. The design is more complex compared to conventional shocks.

- **Energy Storage:**

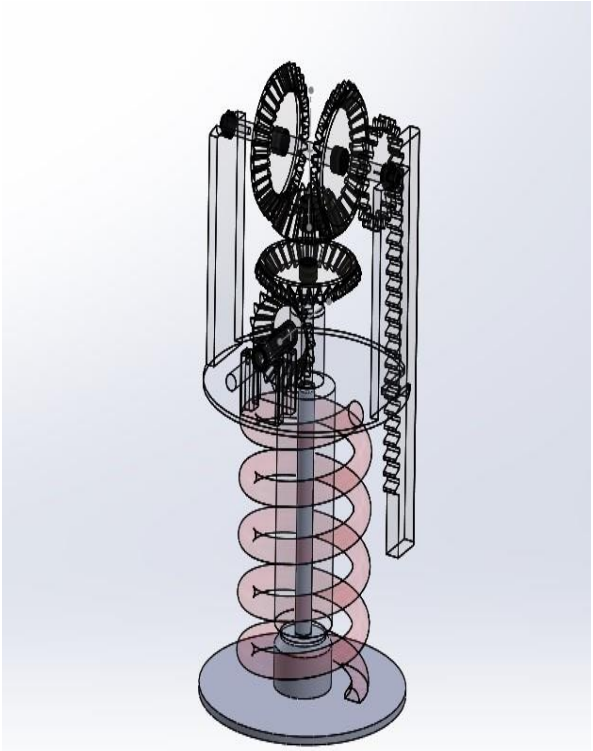
The electrical energy generated is then stored within the vehicle.

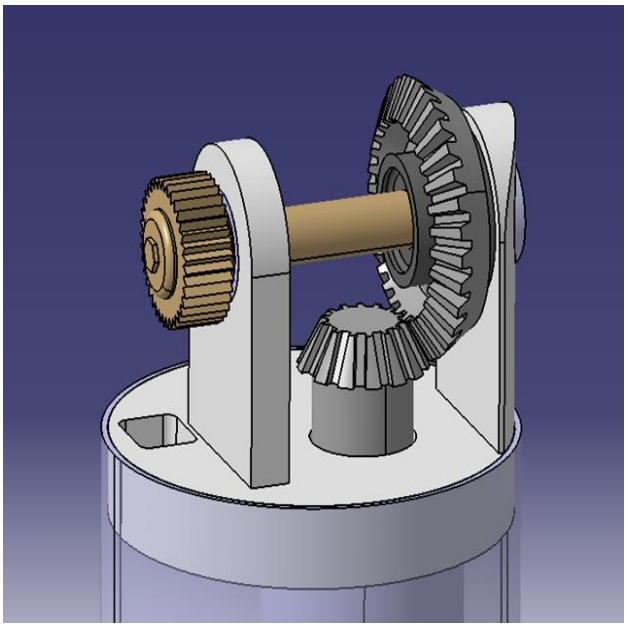
- **Ride Quality and Safety:**

It's crucial that the introduction of regenerative shock absorbers does not compromise ride quality, handling, or safety. These shocks should maintain or enhance the vehicle's suspension performance and safety standards.

5. DESIGN:

CAD Model:





6. CONCLUSION:

Regenerative shock absorbers represent a promising avenue for enhancing the efficiency and sustainability of vehicle systems. The research and development in this area have demonstrated the potential to recover kinetic energy from suspension vibrations and convert it into usable electrical energy. Electric regenerative shock absorbers, in particular, show promise for delivering improved performance and energy regeneration capabilities.

Despite the progress made, challenges such as space constraints and losses in energy conversion still need to be addressed. However, ongoing advancements in technology and design approaches offer opportunities to overcome these limitations.

Moving forward, continued research and innovation in regenerative shock absorbers hold the potential to significantly contribute to the advancement of automotive sustainability and energy efficiency. By optimizing designs, minimizing losses, and integrating regenerative systems into vehicle architectures, we can work towards realizing a future where vehicles not only provide transportation but also actively contribute to energy conservation and environmental stewardship.

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