DEVELOPING AND EVALUATING A FUNCTIONAL MODEL FOR BRAKING REGENERATION

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Abstract: Using motors as brakes, the Regenerative Braking System is a novel method of slowing down a car. The motors act as generators, transforming some of the vehicle's excess energy into electricity that is then sent back into the overhead wires rather than being released as waste heat. The car operates on gasoline and is mostly powered by electrical energy generated by a generator. A huge capacity battery stores this energy, which is then utilized to power an electric motor that turns the wheels. By turning some of the vehicle's kinetic energy back into electrical charge for the battery rather than releasing it as heat through frictional braking, regenerative braking increases efficiency. An alternator and this operate on the same basis .Long battery charging times and a shortage of charging stations continue to be major obstacles as the era of electric vehicles draws near. We suggest a regenerative braking system as a solution. This device helps recharge the battery when braking, bringing us one step closer to cleaner, pollution-free transportation. It produces energy anytime the brakes are used, with more power generated during heavier braking. Regenerative braking lessens reliance on frictional brakes, which deteriorate over time and produce undesired heat, by regenerating some of the vehicle's kinetic energy back into electrical energy while braking. The procedure is scaled to meet the requirements of bigger electric or hybrid power systems and is comparable to an alternator in conventional combustion-engine automobiles. Significant obstacles still stand in the way of an electric vehicle-dominated future, including long battery charging times and a shortage of charging stations. By offering an additional power generation source, the regenerative braking system aids in resolving these problems. The method helps to make electric vehicles greener, more economical, and less dependent on external charging infrastructure by charging the battery during each deceleration event with increased power generated during heavy braking. Regenerative braking is therefore a big step toward environmentally friendly, pollution-free transportation.

Keywords: Energy recovery, kinetic energy conversion, electric motors, hybrid cars, regenerative braking systems, battery recharge, environmentally friendly transportation, frictional brakes, and pollution-free transportation

1. INTRODUCTION:

Brakes are just as important as the engine in cars since they help stop or slow down any moving item. A conventional braking system uses friction to transform kinetic energy into heat in order to slow or stop motion. This happens when a brake liner a frictional rubber pad comes into contact with a moving surface. Inefficiency and energy waste result from the vehicle losing momentum as the brakes engage, forcing the engine to work more to accelerate again. Additionally, this dependence on frictional braking leads to the deterioration of brake parts, necessitating frequent maintenance and material waste. Under contract, a regenerative braking system transforms the kinetic energy of the vehicle into a new form of energy in order to capture and reuse it. In electric trains, for example, this energy can be recycled back into the power supply system during braking. Regenerative braking increases the energy efficiency of automobiles by recapturing energy that would otherwise be lost as heat. This lowers emissions in hybrid systems and fuel consumption. While some systems may compress air or employ a rotating flywheel for energy storage, battery electric and hybrid cars store energy in batteries or capacitors for later use. By helping with acceleration, this stored energy lowers the demand on engine power and improves the vehicle's overall efficiency. Certain sophisticated RBS systems can even increase economy by adjusting to various driving situations, such stop-and-go traffic in cities, where repeated braking might result in a substantial amount of recoverable energy

Applications for regenerative braking systems (RBSs) are numerous. Regenerative braking, which returns about 25% of electrical energy to the power source, is used by many metro trains worldwide. In order to lessen their influence on the environment and save money, RBSs are frequently incorporated into almost all electric and hybrid cars as well as public transportation choices like buses and bullet trains. Regenerative braking is opening the door to a more cost-effective and environmentally friendly transportation future by storing and reusing energy.

2. LITERATURE SURVEY

"Design, Fabrication and Testing of Regenerative Braking Test Rig for BLDC Motor," by Sayed Nashit, Sufiyan Adhikari, Shaikh Farhan, Srivastava Avinash, and Amruta Gambhire, 2016, 1881–84.
This work (1) designs and fabricates a test bench to evaluate a brushless DC motor's capacity for regenerative braking. The project raises engineers' understanding of energy conservation and efficiency. It comes to the conclusion that

regenerative braking systems are more effective at higher speeds and cannot be utilized as a vehicle's sole brake system. Since a portion of lost power may be recovered by employing the regenerative braking system, the technology's clear application as outlined in the project can help us get to a certain point toward a sustainable and bright future of energy-efficient cars.

"Performance Improvement of Regenerativebraking System," Tushar L. Patil, Rohit S. Yadav, Abhishek D. Are, Mahesh Saggam, and Ankul Pratap, International Journal of Scientific & Engineering Research, Volume 9, Issue 5, (2018), 2229-5518.

The methods to improve the regenerative braking system's efficiency are discussed in this paper (2). The method described was to make the car lighter, which improved performance. Using a super capacitor also increases the energy conversion rate in the regenerative braking system, and making the car smaller tends to make the system more efficient.

"Fabrication of Regenerative Braking System" by C. Jagadeesh Vikram, D. Mohan Kumar, and Dr. P. Naveen Chandra, International Journal of Pure and Applied Mathematics, Volume 119, (2018), 9973-9982. The fabrication procedure for the Regenerative Braking System has been carried out in accordance with the guidelines in this document (3), and any further improvements should be handled in accordance with the requirements of the research. For automobile transit to operate at its best, the generative braking system must be implemented.

12 "Design of Regenerative Braking System," International Journal of Advance Research and Innovative Ideas in Education, Vol. 4, Issue 3, 2018, 2395–4396; A. Eswaran, S. Ajith, V. Karthikeyan, P. Kavin, and S. Loganandh. In this paper (4) the regenerative braking system employed in the automobiles satisfies the objective of saving a part of the energy lost during braking. In addition, they are more effective than traditional braking systems and can function in a wide temperature range. More research is needed to create a better regenerative braking system that can stop more quickly and catch more energy. By recovering energy that would have been wasted during braking, these technologies can help all moving vehicles. Utilizing more effective processes could result in significant financial savings for the economy of 12 "Design of Regenerative Braking System," International Journal of Advance Research and Innovative Ideas in Education, Vol. 4, Issue 3, 2018, 2395–4396; A. Eswaran, S. Ajith, V. Karthikeyan, P. Kavin, and S. Loganandh.

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According to this paper (5), the vehicles' regenerative braking system meets the goal of preserving some of the energy wasted when braking. The purpose of the regenerative braking system is to partially recover the battery charge that is lost when the vehicle is braking. Friction brakes transform the energy into heat, which is then released into the surroundings. This energy is used to turn the generator's rotor, which transforms the wheels' mechanical energy into a useable battery charge. Since the regenerative braking system is unable to stop the car, it cannot be employed as the primary braking system. According to experiments, the regenerative braking system can recover at least 11% of the battery energy that would otherwise be squandered as heat in friction brakes. As a result, when regenerative braking is used in real cars, the distance between two consecutive charging needs can be increased by 10% to 15%.

"A Review on Regenerative Braking Methodology in Electric Vehicles," by Siddharth K. Sheladia, Karan K. Patel, Vraj D. Savalia, and Rutvik G. Savaliya, International Journal of Creative Research Thoughts, Volume 6, Issue 1 (2018), 2320-2882.

Regenerative braking can reduce energy waste by up to 25%, according to this article (6). Advanced power electronic components like flywheels, DC-DC converters (Buck-Boost), and ultra-capacitors have been added to the systems. Ultra-capacitors offer a smoother battery charging experience, enhance the overall performance of the electric vehicle system, and help improve the car's transient state during startup.

Buck-boost converters support regenerative braking systems' power management by increasing acceleration. Lastly, the power recovery process through automobile wheels is enhanced by the employment of flywheels. We used the advice and findings from the earlier researcher in our experiment after learning about them. In order to make the experiment more useful and effective, we have additionally modified the parts and procedures as recommended by the researcher. "Regenerative Braking System: Review Paper," Khushboo Rahim and Mohd. Tanveer, International Journal on Recent and Innovation Trends in Computing and Communication, 5.5 (2018), 736-39.

The benefits of regenerative braking systems over traditional braking systems have been discussed in this work (7). When compared to traditional brakes, regenerative braking systems are more efficient and can operate in high temperature ranges. At increased motion, they work better. The more often a car stops, the more this braking system can help it. Large, heavy cars that travel at high speeds accumulate a lot of kinetic energy, which makes them more energy-efficient. There is a lot of room for improvement and energy conservation.

3. **METHODOLOGY**

Components Used In Carrying Out Performance Testing:

Arduino UNO, Battery, DC motors, Wires, Friction Wheel, Linkages, Screws, LCD Display, Voltage Sensor, Supporting Plate, Drum Wheel, etc

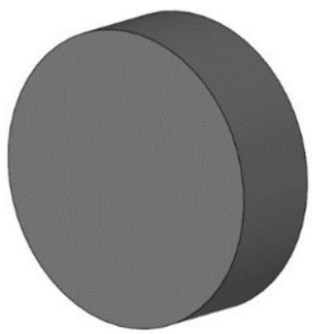

Fig.3.1.Drawing of Friction Wheels

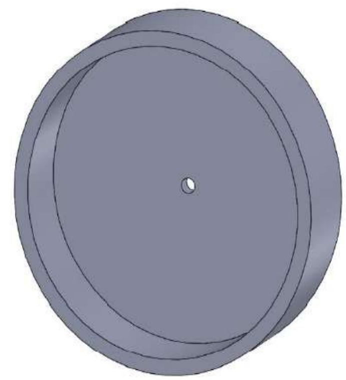

Fig.3.2. Drawing of Drum wheel

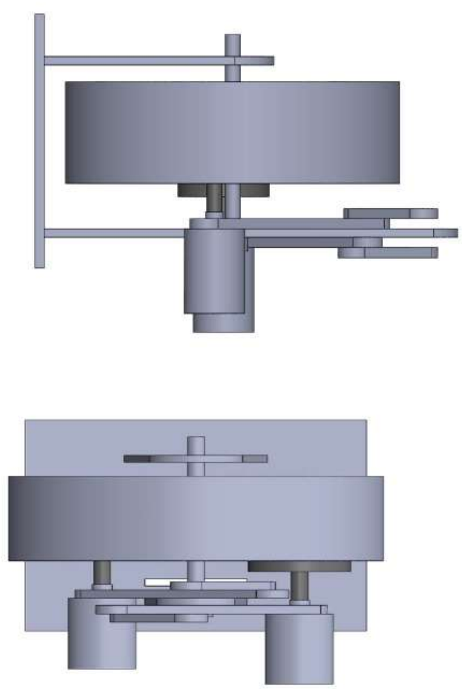

Fig.3.3.Top views of Assembly

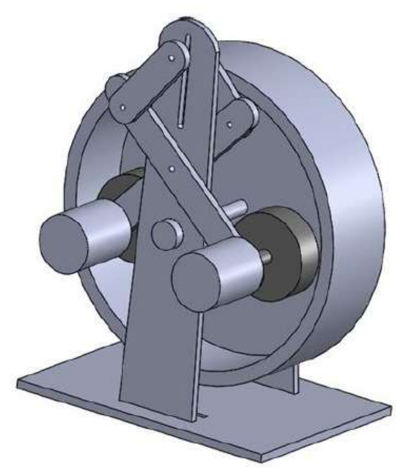

Fig.3.4.Isometric view of Assembly

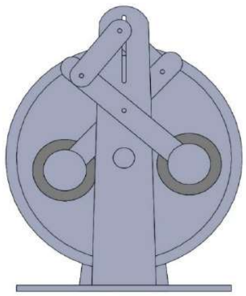

Fig.3.5. Front view of Assembly

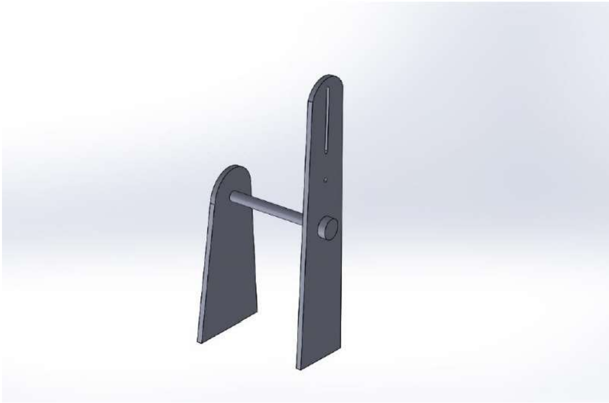

Fig.3.6. Drawing of Supporting Plates

4. **OPERATION**

A friction lining system is employed in brake drums. The friction lining does not immediately make contact with the revolving drum when the brakes are applied. Instead, it makes contact from the inside, which rotates the motors attached to the lining in the opposite direction, creating energy like dynamos. This slows down the drum wheel and captures energy that would otherwise be lost as heat, converting it back into useful power. With this setup, the battery can be charged each time the brakes are applied. Regenerative braking provides additional benefits by interacting with various driving scenarios. Regenerative braking occurs while the vehicle is in motion, such as when coasting, stopping, or descending without using the gas pedal. In this mode, the motor generates electricity and feeds it back into the batteries. This energy recovery is particularly useful when traveling in urban areas because there are numerous opportunities to recharge the battery without relying solely on external charging outlets because of frequent stops and starts. Thus, in addition to increasing fuel efficiency and reducing wheel pollution, regenerative braking increases the lifespan of brake components by reducing wear.

5. OUTCOME

A regenerative braking system model has been made. The mechanism can halt the wheel while replenishing energy once testing is complete.

Fig.5.1. When RBS brake is not applied

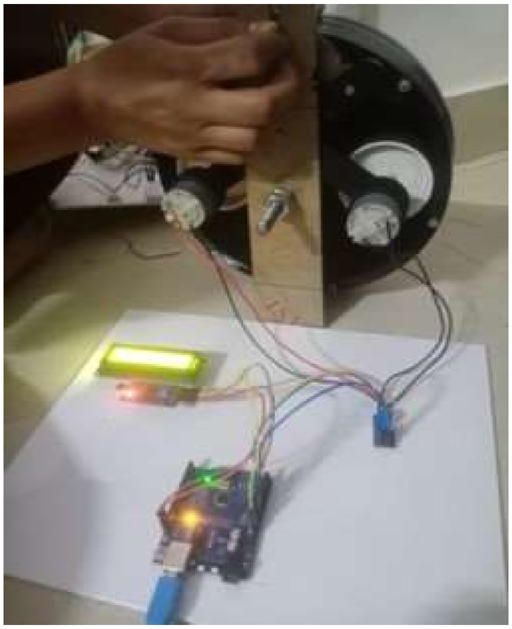

Fig 5.2: When RBS is applied

The motor that turned the drum wheel was powered by a 12V battery.
The voltage produced by the dynamo when the brake was applied was measured as follows.

TEST NUMBER	VOLTAGE (MV)
1	250 MV
2	430 MV
3	200 MV
4	500 MV
5	400 MV

A variance in output voltage was noted as a result of variations in the applied (pressing) braking power. Calculating the observation's average:

The average is 250 + 430 + 200 + 500 + 400 5 ▸ the average voltage is 356 mV.

Next, figuring out the percentage of power that would be returned to the battery during typical braking,

The average voltage generated by braking multiplied by the battery's voltage

356 x 100 = 12000 ▸ 2.97%

The regeneration system's efficiency is 2.97%.

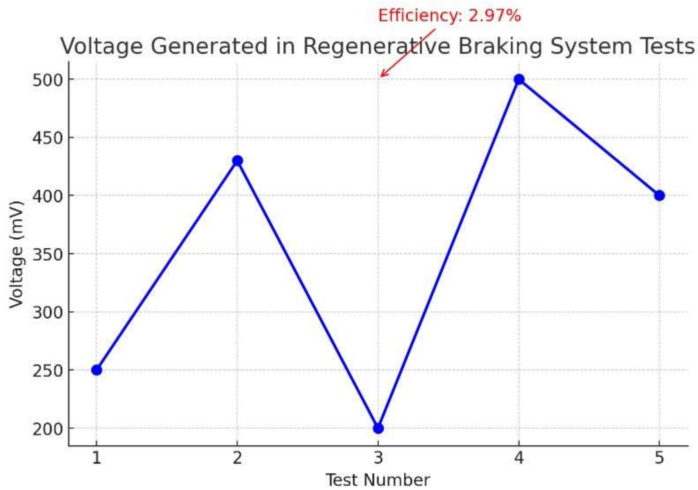

Fig 5.3: Voltage VS Test number graph

6. CONCLUSION

We created and assessed a regenerative braking system model to ascertain the system's capability for energy recovery. The regeneration efficiency, as established by system simulation and experimentation, was 2.7%. This efficiency reflected the process of converting kinetic energy into electrical energy. Problems like system constraints and energy losses have an impact on this performance. Despite these drawbacks, the study was able to effectively illustrate the fundamental operation of regenerative braking. The information gained from this endeavor can serve as a foundation for additional research and development targeted at boosting efficiency, including the addition of state-of-the-art materials, enhanced electrical components, and improved system architecture. With additional development, regenerative braking systems could play a major role in sustainable energy solutions. This initiative lays the groundwork for upcoming developments in energy-efficient braking systems and emphasizes the value of innovation in sustainable technology.

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