International Journal of Innovative Studies in Sciences and Engineering Technology
ISSN 2455-4863 | Open Access | Volume 7, Issue 2, 2021
DOI: https://doi.org/10.20431/2455-4863.070201

Design and Development of Regenerative Braking System for Electric Vehicle

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ABSTRACT

Most brakes commonly use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat, though other methods of energy conversion may be employed as all the energy here is being distributed in the form of heat. Regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Driving an automobile involves many braking events, due to which higher energy losses takes place, with greater potential savings. With buses, taxis, delivery vans and so on there is even more potential for economy. As we know that the regenerative braking, the efficiency is improved as it results in an increase in energy output for a given energy input to a vehicle.

In this work, a new methodology with external generator is developed for regenerative braking system. Experimental test setup is developed to verify the feasibility of new methodology. Results are verified using Matlab Simulink simulation. About 10 to 12% of battery energy can be regenerated and stored into battery which shows 10 to 12% increase in Electric vehicles mileage.

Keywords: Regenerative brake, Motor/generator unit, Energy losses

INTRODUCTION

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 [1]. 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 [2]. A brake is a mechanical device that inhibits its motion by absorbing energy from a moving system. It is used for slowing or stopping a moving vehicle, wheel, axle, or to prevent its motion, most often accomplished by means of friction. The term 'Braking' in a moving vehicle means the application of the brakes to reduce its speed or stop its movement, usually by depressing a pedal [3]. The braking distance is the distance between the time the brakes are applied and the time the vehicle comes to a complete stop. In braking systems on conventional vehicles, friction is used to counteract the forward momentum of a moving vehicle. As the brake pads rub against the wheels or a disc that is connected to the axles, excessive heat energy is created. This heat energy dissipates into the air wasting as much as 30 percent of the vehicle's generated power [4]. Over time, this cycle of friction and wasted heat energy reduces the vehicle's fuel efficiency. More energy from the engine is required to replace the energy that was lost by braking. Most of it simply gets released in the form of heat and becomes useless [5]. That energy, which could have been used to do work, is essentially wasted. The solution for this kind of this problem is Regenerative Braking System. This is a new type of braking system that can recollect much of the car & kinetic energy and convert it into electrical energy or mechanical energy. The energy so produced can then be stored as mechanical energy in flywheels, or as, electrical energy in the automobile battery, which can be used again There are 7 multiple methods of energy conversion in RBSs including spring, flywheel, electromagnetic and hydraulic. More recently, an electromagnetic-flywheel hybrid RBS has emerged as well. Each type of RBS utilizes a different energy conversion or storage method, giving varying efficiency and applications for each type [6]. The effect of regenerative brakes is less at lower speeds as compared to that at higher speeds of vehicle. So the friction brakes are needed in a situation of regenerative brake failure, to stop the vehicle completely.

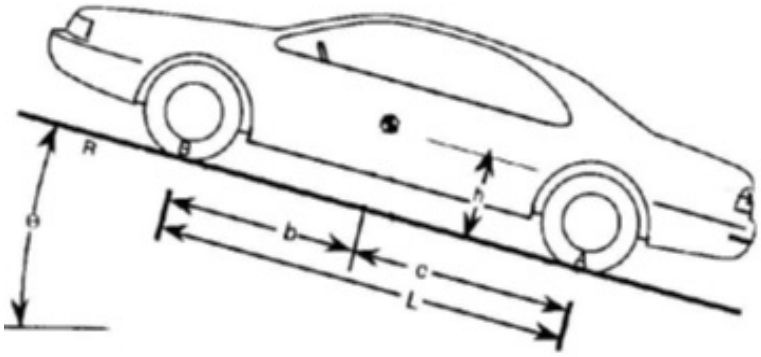


Figure1. Vehicle length parameters

SPECIFICATION OF PROPOSED MECHANISM

These machines are small enough to operate manually.

1. Function : Generate electricity when apply brakes.

2. Specification :

i. Type: Motor operated

ii. Power: - PMDC motor.

iii. Man power requirement: - Diver of vehicle.

iv. Overall dimensions (Tentative): 900x 900x 600 mm

v. Capacity: 150 watt motor.

Vii. Speed capacity:- 3 modes for take readings.

vii. General Information :

The machine consist of mechanical linkages for conventional braking. Charging unit.

3. Analysis of different critical parts of mechanism.

4. Selection of materials and drives.

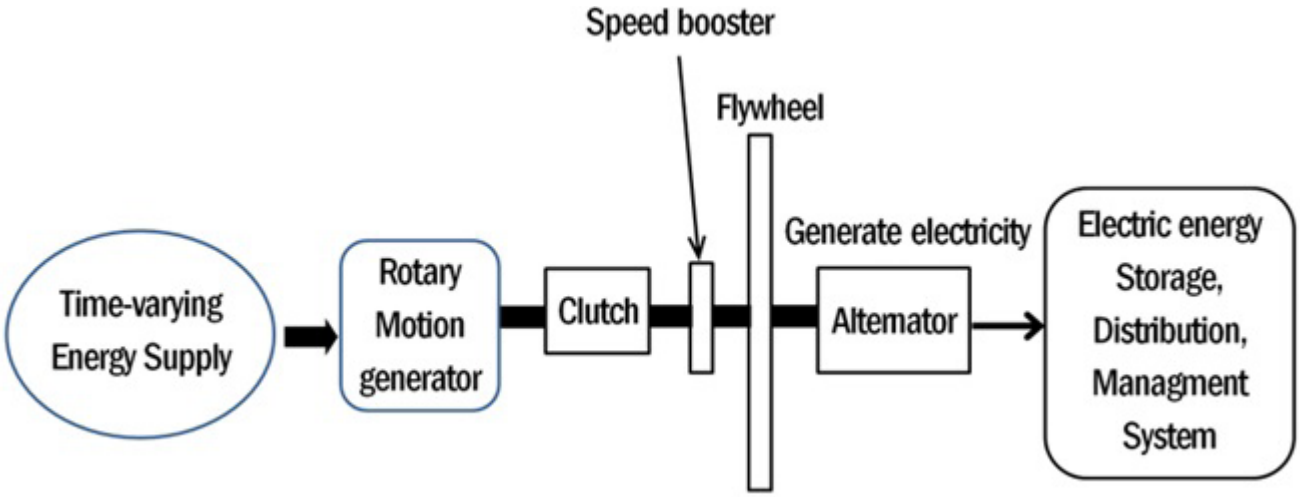


Fig1. Proposed set up for regenerative braking system.

DESIGN CONSIDERATIONS

When designing our attachment, the following considerations were taken into account

1. The device should be suitable for local manufacturing capabilities.

2. The attachment should employ low-cost materials and manufacturing methods.

3. It should be accessible and affordable by low-income groups, and should fulfill their basic need for mechanical power

4. It should be simple to manufacture, operate, maintain and repair.

5. It should employ locally available materials and skills. Standard steel pieces such as steel plates, iron rods, angle iron, and flat stock that are locally available should be used. Standard tools used in machine shop such as hack saw, files, punches, taps & dies; medium duty welder; drill press; small lathe and milling machine should be adequate to fabricate the parts needed for the machine.

6. Excessive weight should be avoided, as durability is a prime consideration

Design of Hinge Shaft for Pedal.

In the proposed mechanism we have used arrangement as shown in fig. 1

Load on shaft considered= 10 kg = 100N

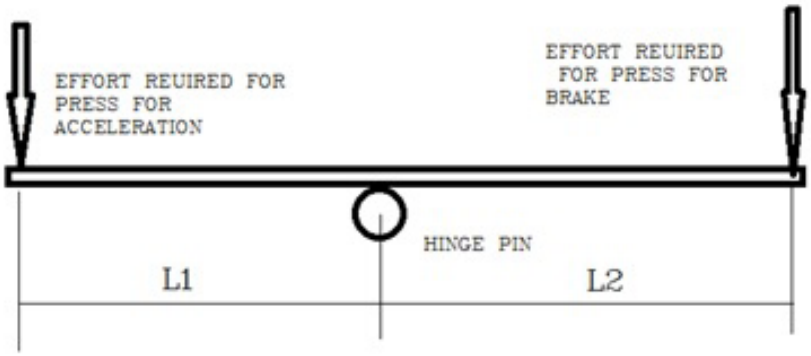
Considered speed of machine N =30 rpm

Maximum lever L 1 = L2 = 100mm

For design load considered = 25 kg = 250N

So Maximum Torque T = Effort x Lever arm

Total torque on sprocket shaft = 250x100 = 25000 N-m



Construction and Working :

When driving motor will get start, wheel starts rotating in clockwise direction. This clockwise motion is also transferred to the second shaft through the timing pulley. We are using Timing pulley, the friction losses are neglected. Motion which is transmitted to the sprocket shaft is carried to flywheel is connected on shaft. Motion of the shaft is transmitted to the flywheel and it is connected with the dynamo. The dynamo is used to convert the rotational energy to the mechanical energy. Basically its work is to store the energy. When we apply the brake the motor continues to work but the wheel gets stopped and thus the sprocket shaft also gets stopped but the flywheel keeps on rotating which stores the waste energy of the wheel lost due to friction or heat to the atmosphere. Now this rotating mechanical energy is transferred to the dynamo from where battery or any equipment is connected which can work by taking this energy. Dyanamo connected to the flywheel means of gear pair converts rotational mechanical energy to electrical energy. Potentiometer which regulates the voltage is used for varying the speed. By regulating the voltage we can vary the input speed from

which different readings are taken by connecting different load. Regenerative braking systems recapture some of the vehicle's kinetic energy when the brakes are applied and store this energy so that it can be used to reduce the engine load when the vehicle accelerates. It is widely used in electric and hybrid electric vehicles that already have batteries to store the recaptured energy. Regenerative braking has minimal impact on fuel economy during highway driving, but it can significantly improve the fuel economy of vehicles that are driven primarily in city traffic. In heavy vehicles that make frequent stops (e.g. garbage trucks), regenerative braking systems can improve fuel economy substantially. Electric and hybrid electric vehicles typically employ motor-generators that can convert electric current into torque (like a motor) or torque into electric current (like a generator). When the brakes are applied, the motor-generator provides the resistance necessary to slow the vehicle as it supplies current to the battery. In the event that the motor-generator cannot slow the vehicle fast enough, a torque coordinator module will apply traditional friction brakes to the extent necessary

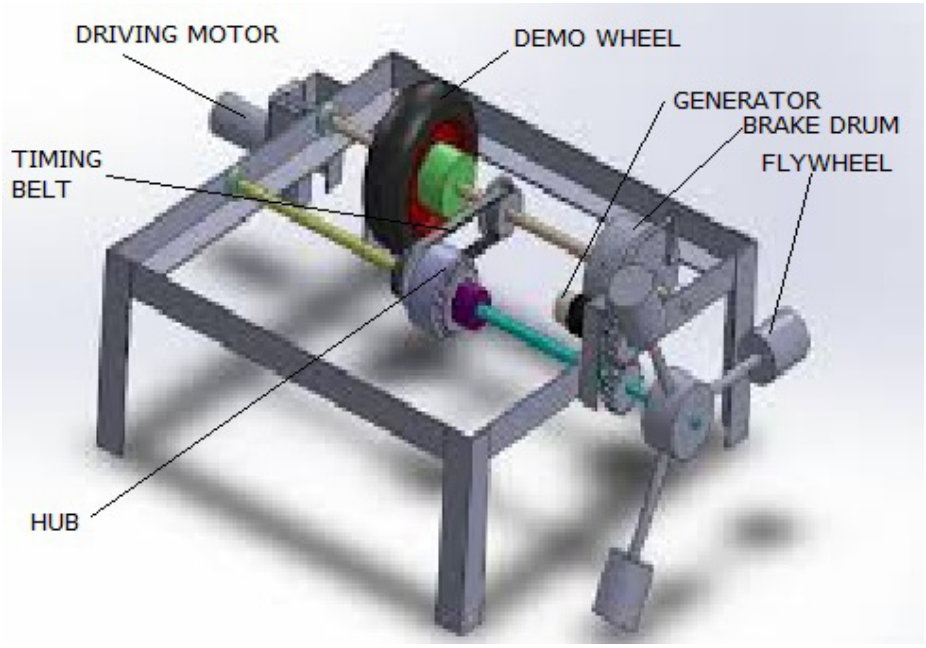


Fig2. Assembly of Set up

CONCLUSION:

The regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking.

The regenerative braking system is designed to partially recover the battery charge wasted in braking of the vehicle. The energy is converted into heat by friction brakes which is dissipated to the environment. This Energy is utilized to rotate the rotor of generator converting mechanical energy of wheels into useful charge of battery.

The regenerative braking system cannot be used as main braking system of vehicle as it cannot bring the vehicle to rest.

Experimentation shows that minimum 11% battery energy can be recovered using the regenerative braking system which would otherwise be wasted to heat in friction brakes. Hence the distance travelled between two successive charging requirements can be increase to 10 to 15 % using this regenerative braking, when installed in actual vehicle.

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Citation: *S.S.Chougule, S.Y.Dhumal, P.D.Aware, et.al. Design and Development of Regenerative BrakingSystem for Electric Vehicle. Int J of Innovative Studies in Sciences and Engineering Technology. 2021; 7(2): 1-5. DOI: https://doi.org/10.20431/2455-4863.070201.*