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Regenerative Braking System

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ABSTRACT

Regenerative braking system is a small, but an eventual method for converting unwanted heat energy into electrical energy. The energy generated is stored in the battery. This helps in reducing the usage of the external battery for charging purposes. These types of brakes helps in increasing the driving range for the electric vehicles as they can travel for longer periods. Regenerative braking system also in improving the fuel economy. It is a way of increasing the efficiency rate of the vehicles.

Instead, of converting the kinhetic energy into thermal energy through friction braking; this system can convert a good fraction of kinetic energy into electric energy and charge the battey using the principle of alternator.

KEYWORDS: *kinetic energy, regenerative system, Conservation of friction energy, alternator, electrical battery, efficiency rate, potential*

INTRODUCTION

When a conventional vehicle applies brakes then the kinetic energy gets converted into heat as friction comes into play between brake pads and wheel. The heat is carried away in the airstream and some effective energy gets wasted. The amount of energy wasted depends on how long and how hard the brakes are applied.

Regenerative braking is defined as a process in which a small portion of kinetic energy is stored in the system of the vehicle. The energy dissipated in the brakes is directed by power transmission to energy store during decelaration. The energy is held for the further requirement by the vehicle, whereby it is converted into kinetic energy to accelerate the vehicle.

This results in increasing the efficiency of the vehicle and the drving of the vehicles in the cities involve more braking events representing a much higher loss with greater potential savings. With buses, taxis, delivery vans and so on there is even more potential for economy.

Since, Renegerative Braking System has resulted in increasing the output rate of a vehicle, it has also increased the efficiency of the vehicle. With this system the energy required by engine gets reduced and in turn reducing the energy required to propel the vehicle.

The energy stored int the system must be compact in nature, highly durable and capable of handling high power levels efficiently and the energy transfer or energy conversion must be efficient compact at affordable cost.

For an ideal Regenerative Braking System they should follow the following properties

- Efficient energy conversion
- An energy stored in high capacity with weight and volume
- Should not complicate the vehicle system
- Smooth delivery of power
- Should store the energy as proptional to the braking applied on vehicle

NEED OF REGENERATIVE BRAKING SYSTEM

In low speed and stop and go traffic where the little decelaration is required, the regenerative braking system can provide the maximum output of the total braking force.This highly improves the efficiency and also results in improving

the fuel economy of a vehicle, further enhances the attractiveness of vehicles using regenerative braking for city driving.

At high speed too, regenerative braking system has shown the improvement in the fuel economy as much as 20%.Hybrids and electric cars also do have friction brakes that act as a type of back-up system in scenarios where regenerative braking can't supply enough power to stop. In these cases, drivers should aware that the brake pedal could respond differently to pressure. It will sometimes depress farther towards the floor than usual -- a feeling that can momentarily cause drivers to panic.

Advantages of regenerative braking system

- Improves Fuel Economy
- Emissions Reduction
- Improves performance of vehicle
- Reduce engine wear
- Reduce brake wear
- Accessories required are small
- Operational range is better than conventional braking

The possible disadvantages of Regenerative Braking System

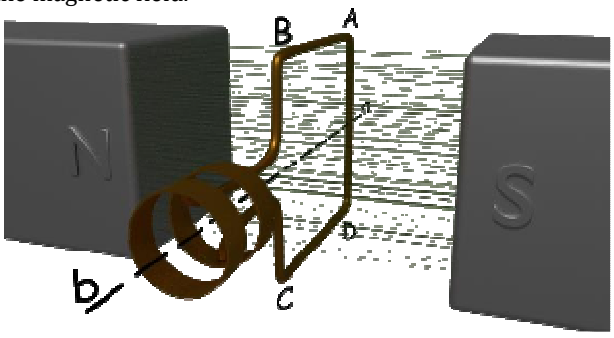
- Extra weight added in vehicle
- Complex Arrangement of the system
- Available at reasonable cost if this has mass production
- Noise production depends on the system
- It adds extra maintainence requirement

HYBRID VEHICLES

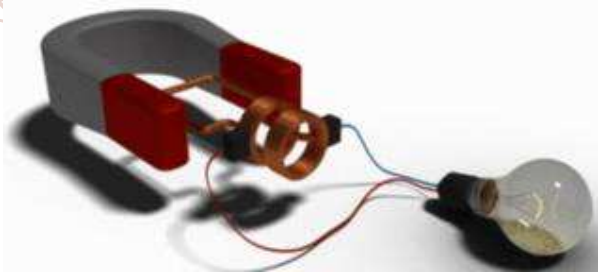
Hybrid electric vehicles use both an electric motor as well as an internal combustion engine to provide a best of both system driving experience. They combine the driving range of an internal combustion engine with the fuel efficiency and emissions-free characteristics of an electric motor. If a hybrid is to have maximum fuel efficiency and produce as few carbon emissions as possible, it's important that the battery remain charged as long as possible. If a hybrid vehicle battery were to lose its charge, the internal combustion engine would be entirely responsible for powering the vehicle. At that point, the vehicle is no longer acting as a hybrid but rather just another car burning fossil fuels.

ALTERNATOR

The **working principle of alternator** is very simple. It is just like basic principle of DC generator. It also depends upon Faraday's law of electromagnetic induction which says the current is induced in the conductor inside a magnetic field when there is a relative motion between that conductor and the magnetic field.



Having understood the very basic principle of an alternator, let us now have an insight into its basic operational principle of a practical alternator. During discussion of basic **working of an alternator**, we have considered that the magnetic field is stationary and conductors (armature) is rotating. But generally in practical construction of alternator, armature conductors are stationary and field magnets rotate between them. The rotor of an alternator or a synchronous generator is mechanically coupled to the shaft or the turbineblades, which being made to rotate at synchronous speed N_s under some mechanical force results in magnetic flux cutting of the stationary armature conductors housed on the stator. As a direct consequence of this flux cutting an induced emf and current starts to flow through the armature conductors which first flow in one direction for the first half cycle and then in the other direction for the second half cycle for each winding with a definite time lag of 120^o due to the space displaced arrangement of 120^o between them as shown in the figure below. This particular phenomenon results in three phase power flow out of the alternator which is then transmitted to the distribution stations for domestic and industrial uses.



DESCRIPTION

Regenerative braking systems recover useful kinetic energy (into electrical potential energy) only to immediately set apart against electric propelling force motors. While this seems very appropriate and logical in a dedicated hybrid system, it may be possible to recover the useful energy in conventional vehicles.

Detailed Overview

The idea of this project is to capture kinetic energy from a moving vehicle during the region of adjoining operations and convert it into electrical energy using the vehicle's existing alternator. This energy is to be stored in a user-removable 'battery' of 12V that can be used for secondary purposes.

Processing

Consider an example, your vehicle is travelling at a moderately fast speed at highways speeds. At some point, you need to exit the highway (using a typical offramp). Instead of mechanical braking (converting the vehicle kinetic energy into thermal energy), an on vehicle DC-DC converter is activated which takes electrical energy from the vehicle's alternator to the 'battery'. The logic is composed of an onboard CANbus(Controlled Area Network) monitor which is continuously monitoring the fuel consumption by vehicle, throttle input, brake input, and speed. The simplified algorithm considers these 4 inputs and decides if there is a 'near-zero' fuel consumption condition in which activating the DC-DC converter will affect the fuel consumption rate.

Testing

To simplify the project, I looked at the effects the Air Conditioner has on the fuel consumption rate. Since both the A/C and alternator are both belt- driven off of the auxiliary power output of the engine, the A/C appeared to be a good 'equivalent' loading method to simulate a DC-DC converter system (which I don't actually have), pulling somewhere between 5-10HP (3.7-7.5kW) at full load. After connecting to the vehicle CANbus, I took a typical commute route with the AC and HVAC fan on HIGH, recording a variety of parameters. On this typical commute, about 8% of the journey was in a reported 'zero' fuel consumption rate, always while coasting to a stop or turn. If the fuel consumption rate is real (from the CAN messages) - this means that the AC was delivering 'free' energy during these coasting situations.

Results

1. Yes - it is totally feasible and does offer significant energy reclamation opportunities up to (≃280Wh)
2. No - it does not appear to be cost effective, as the electronics and battery would never pay for itself.

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