Regenerative Braking System in Automobiles

Siddharth K. Patil
Vishwakarma Institute of Information Technology, Pune, Maharashtra, India

Abstract
As in today's world, where there are energy crises and the resources are depleting at a higher rate, there is a need of specific technology that recovers the energy, which gets usually wasted. So, in case of automobiles one of these useful technology is the regenerative braking system. Generally in automobiles whenever the brakes are applied the vehicle comes to a halt and the kinetic energy gets wasted due to friction in the form of kinetic energy. Using regenerative braking system in automobiles enables us to recover the kinetic energy of the vehicle to some extent that is lost during the braking process. In this paper the author discusses two methods of utilising the kinetic energy that is usually wasted by converting it into either electrical energy or into mechanical energy. Regenerative braking system can convert the kinetic energy into electrical energy with help of electric motor. And it can also convert the kinetic energy into mechanical energy, which is supplied to the vehicle whenever it is needed, with the help of a flywheel.

Keywords
Conventional Braking System, Regenerative Braking, Electric Motor, Flywheel Energy Storage

I. Introduction

A. Introduction to Conventional Braking System

Braking in a moving vehicle means the application of the brakes to slow or stop its movement, usually by depressing a pedal. The braking distance is the distance between the time the brakes are applied and the time the vehicle comes to a complete stop.
When brakes are applied to a vehicle using conventional braking system, kinetic energy is converted into heat due to the friction between the wheels and brake pads. This heat is carried away in the airstream and the energy is wasted. The total amount of energy lost in this process depends on how often, how hard and for how long the brakes are applied.

B. Introduction to Regenerative Braking System

Regenerative braking is one of the emerging technologies which can prove very beneficent. The use of regenerative braking in a vehicle not only results in the recovery of the energy but it also increases the efficiency of vehicle(in case of hybrid vehicles) and saves energy, which is stored in the auxiliary battery.

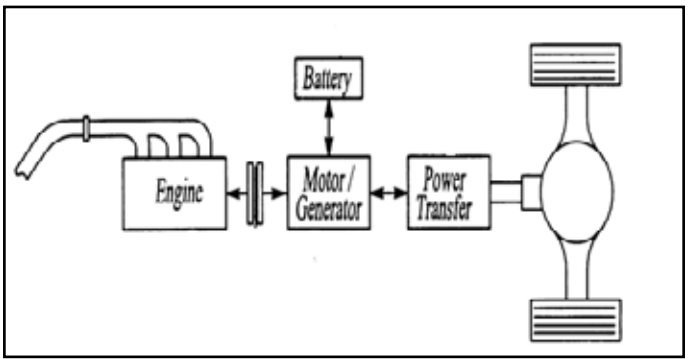

Fig. 1: Simple Representation of Regenerative Braking System

In cities, driving involves many braking events resulting in much higher energy losses with greater potential savings. With buses, taxis, delivery vans and so on there is even more potential for economy. Since regenerative braking results in an increase in energy output for a given energy input to a vehicle, the efficiency is improved. The amount of work done by the engine of the vehicle is reduced, in turn reducing the amount of energy required to drive the vehicle.
This technology of regenerative braking controls the speed of the vehicle by converting a portion of the vehicle's kinetic energy into another useful form of energy. The energy so produced could then be stored as electrical energy in the automobile battery, or as mechanical energy in flywheels, which can be used again by the vehicle.

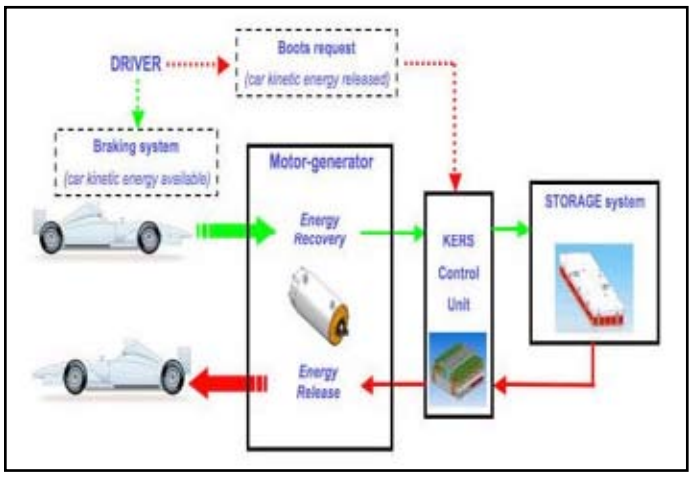

Fig. 2: Block Diagram of Regenerative Braking System

Regenerative braking refers to a process in which a portion of the kinetic energy of the vehicle is stored by a short term storage system. Energy normally dissipated in the brakes is directed by a power transmission system to the auxiliary battery during deceleration [1]. The energy that is stored by the vehicle, is converted back into kinetic energy and used whenever the vehicle is to be accelerated. The magnitude of the portion available for energy storage varies according to the type of storage, drive train efficiency, drive cycle and inertia weight [1]. 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.

II. Working of Regenerative Braking using Electric Motor

The working of the regenerative braking system depends upon the working principle of an electric motor, which is the important component of the system.

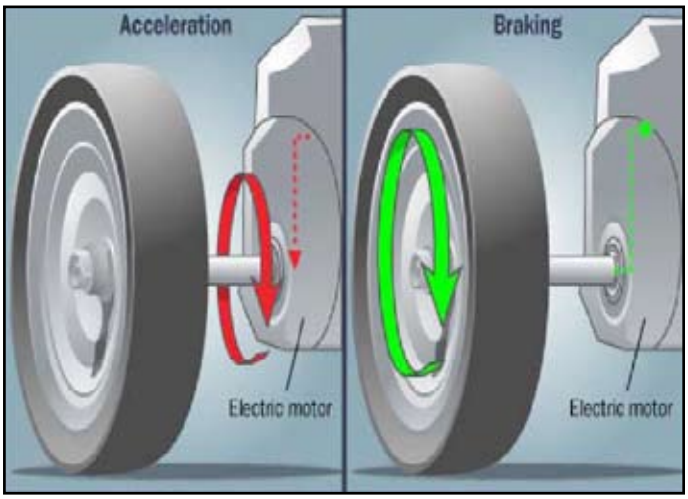

Fig. 3: Operation of Electric Motor

Generally the electric motor, is actuated when electric current is passed through it. But, when some external force is used to actuate the motor (that is during the braking process) then it behaves as a generator and generates electricity. That is, whenever a motor is run in one direction the electric energy gets converted into mechanical energy, which is used to accelerate the vehicle and whenever the motor is run in opposite direction it functions as a generator, which converts mechanical energy into electrical energy. This makes it possible to employ the rotational force of the driving axle to turn the electric motors, thus regenerating electric energy for storage in the battery and simultaneously slowing the car with the regenerative resistance of the electric motors [2]. This electricity is then used for recharging the battery.

III. Flywheel Energy Storage

The energy (mechanical) stored in the flywheel is directly given to the vehicle so as to boost its acceleration instantaneously, whenever needed. Generally, the method of transmission of energy directly to the vehicle is more efficient rather than storing it in the battery, as it does not consists of the conversion of energies. As, during the recharging of battery, mechanical energy is converted into electrical energy and during discharging electrical energy is converted into mechanical energy. So, due to these conversions transmission loses occur and the efficiency reduces. As, in the other case, there are no transmission loses since mechanical energy stored in the flywheel is directly transferred to the vehicle in its original form. Because of the instant energy supply and high efficiency these type of system is used in F-1 cars.

IV. Advantages

Better fuel economy.
Reduced CO2 emissions.
Approximately 30% saving in fuel consumption.
The lower operating and environment cost of the vehicle with regenerative braking system.

V. Future Scope

As in regenerative braking system about 30% of the energy is recuperated, also the system of regenerative braking increases the weight of the vehicle by approximately 25 kgs. So rather than manufacturing the metallic gears and metallic flywheel, carbon fibre can be used which will not only reduce the weight of the system but also it will reduce the transmission loses.

VI. Conclusion

The regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. Also it can be operated at high temperature range and are efficient as compared to conventional braking system. The results from some of the test conducted show that around 30% of the energy delivered can be recovered by the system.
Regenerative braking system has a wide scope for further development and the energy savings. The use of more efficient systems could lead to huge savings in the economy of any country.

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Siddharth Kishor Patil received his bachelor degree in mechanical engineering, from Vishwakarma Institute of Information Technology, Pune, under University of Pune, in 2012. At, present he is working on a project in Computational Fluid Dynamics. His research interests to include Fluid mechanics, automobile engineering and Computational fluid dynamics.