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Power Generating Magnetic Shock Absorber

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Abstract — *The function of vehicle suspension system is to support the weight of vehicle body, to isolate the vehicle chassis from road disturbances, and to enable the wheels to hold the road surface. A magnetic shock absorber which makes use of the magnetic repulsion between dipoles to achieve shock absorption, the suspension system consists of magnets freely moving inside the cylinder with their same poles facing each other. Since the magnetic poles repel each other while moving closer, the up and down spring action is obtained. This shock absorber will eradicate the problems faced in the spring shock absorbers due to friction and other factors. This will also reduce the maintenance costs as it does not need repairing, changing of springs or dealing with leakage problems as in spring or oil shock absorbers. This magnetic shock absorber can be used in vehicles carrying heavy or less load. Presented in this paper the method aimed at determining the effectiveness of efficiently transforming suspension energy into electrical power by using regenerative magnetic shock absorbers. In turn, the electrical power can be used to recharge batteries or other efficient energy storage devices rather than be dissipated.*

Keywords-*Magnetic Power, Magnets, Repulsion Force, Energy Recovery, Suspension System, Spring.*

I. INTRODUCTION

Suspensions are undoubtedly the most important & mandatory units of any automotive vehicle. These ensure the vehicle performance such as road handling, ride comfort etc. The irregularities, acceleration, braking etc enabled the suspension to contract and expand. This energy is surely an ample amount since neither you can avoid the road irregularities nor acceleration & braking. So, why not incorporate this energy back to the system to enhance the efficiency. Hence, the paper elaborates the system to harness electrical energy using the input source of mechanical/vibration energy from the suspension.

The idea for a magnetic shock absorber (for automobiles and two-wheelers) makes use of the magnetic repulsion between dipoles to achieve shock absorption. Often when riding on two-wheeler we used to face some problems while moving on the bumpy road due to its unevenness. It observed that the like poles of two magnets of the same properties and strength repulse each other and they keep a constant distance between each other because of their magnetic fields. If the shock absorbers are made of magnets with similar poles facing each other, it may give better performance and no maintenance would be required for the same. The unit comprises of two circular magnets and a rod (straight cylindrical rod which can be used as axle). One magnet is attached at the bottom of the rod and is the base magnet. The other magnet is free, with a float and has the similar pole placed towards the base magnet. The similarity of poles creates repulsion and a certain distance is maintained. as per load condition, the floating magnet moves and closes the gap until the magnetic repulsion is strong enough to create the damping action in this manner a shock absorber without springs working on the basic law of magnets -opposite poles attract and similar poles repel- is prepared.

1.1 The new wave in shock absorbers

Over the past two model years, General Motors (GM) has introduced one of the most interesting and potentially far-reaching new technologies ever developed for automobiles. The Chevrolet corvette and the Cadillac SRX, STS and XLR models are all available with magnetic ride control, called Magneride by its supplier Delphi automotive systems; it uses a computer to adjust the shock absorbers damping rate. While electronic damping adjustment is nothing new, the shock absorbers themselves are different from anything you've seen before. Instead of adjustable valves, these shocks have adjustable oil. A hydraulic shock absorber dampens suspension movement by forcing a piston to move through oil. Holes in the piston are covered by spring-loaded valves. These valves slow the flow of oil through the holes to control damping rate: the smaller the valve opening, the slower the oil flow and the greater the damping. Adjustable shock absorbers vary the shock's damping rate by varying the size of the valve opening, either by adjusting the spring preload or by selecting a different size oil flow orifice.

1.2 Suspension system

The automobile chassis is mounted on the axles, not direct but through some form of springs. This is done to isolate the vehicles body from the road shocks which maybe in the form of bounce, pitch, roll or sway. These tendencies give rise on an uncomfortable ride and also cause additional stress in the automobile frame and body. All the parts which perform the function of isolating the automobile from the road shocks are collectively called a suspension system. It includes the springing device used and various mountings for the same.

1.3 Shock absorber

Shock absorber will not absorb road shocks efficiently if the suspension springs are highly rigid. They will be continuous vibrated for a long time if the springs are sufficiently flexible. To overcome this difficulty, a system having compromise between flexibility and stiffness should be used. Shock absorbers are used as a part of the suspension system. They provide more resistance to the motion of the spring and road wheel in order to damp out vibrations.

1.4 Project scope

This shock absorber will eradicate the problems faced in the spring shock absorbers due to friction and other factors. This will also reduce the maintenance costs as it does not need repairing, changing of springs or dealing with leakage problems as in spring or oil shock absorbers. This magnetic shock absorber can be used in vehicles carrying heavy or less load. Improving on the concept to make these magnetic shock absorbers even better, a chain of more than two magnets can be used to tolerate the shocks or weight and make the vehicle more comfortable.

II. LITERATURE REVIEW

In the early 1900's, early drivers had bigger things to worry about than the quality of their ride – like keeping their cars rolling over the rocks and ruts that often passed for roads. Pioneering vehicle manufacturers were faced early on with the challenges of enhancing driver control and passenger comfort. These early suspension designs found the front wheels attached to the axle using steering spindles and kingpins. This allowed the wheels to pivot while the axle remained stationary. Additionally, the up and down oscillation of the leaf spring was damped by device called a shock absorber. These first shock absorbers were simply two arms connected by a bolt with a friction disk between them. Resistance was adjusted by tightening or loosening the bolt. As might be expected, the shocks were not very durable, and the performance left much to be desired. Over the years, shock absorbers have evolved into more sophisticated designs.

The research about energy recovery from vehicle suspensions began more than ten years ago, first as an auxiliary power source for active suspension control, and later also as energy regenerating devices in their own accord. During the past ten years, energy recovery from vehicle vibrations has achieved great commercialization success in hybrid or electric vehicles. Some earlier efforts to recover energy from suspension are-

[1] S. Mirzaei, S.M. Saghaiannejad, V. Tahani and M. Moallem, "Electromagnetic shock absorber", S. Mirzaei, have introduced a passive suspension system for ground vehicles based on a flexible Electromagnetic Shock Absorber (EMSA). They designed and provided a model of passive suspension.

[2] Bart L. J. Gysen, Jeroen L. G. Janssen, Johannes J. H. Paulides, Elena A. Lomonova, "Design aspects of an active electromagnetic suspension system for automotive applications", Bart Gysen, have studied design aspects of an active electromagnetic suspension system which combines a brushless tubular permanent-magnet actuator with a passive spring.

[3] Babak Ebrahimi, Mir Behrad Khamesee, M. Farid Golnaraghi, "Feasibility Study of an Electromagnetic Shock Absorber with Position Sensing Capability", Babak Ebrahimi, has presented the feasibility study of an electromagnetic damper, as senor/actuator, for vehicle suspension application. They have optimized geometry of shock absorber to achieve higher electromagnetic forces and magnetic flux induced in the system..

[4] Gupta A, Jendrzejczyk J A, Mulcahy T M and Hull J R, "Design of electromagnetic shock absorbers", Gupta A, has studied the available energy from shock absorbers as cars and trucks are driven over various types of roads. They fabricated two prototypes of regenerative electromagnetic shock absorber: a linear device (called as Mark 1) and a rotary device (called as Mark 2) and installed them in vehicle to study energy recovery.

[5] Goldner R B, Zerigian P and Hull J R, "A preliminary study of energy recovery in vehicles by using regenerative magnetic shock absorbers", Goldner R B, have carried out a proof-of-concept - to evaluate the feasibility of obtaining significant energy savings by using regenerative magnetic shock absorber in vehicles. They proposed electromagnetic (EM) shock absorbers to transform the energy dissipated in shock absorbers into electrical power.

[6] Lei Zuo, Brian Scully, Jurgen Shestani and Yu Zhou, "Design and characterization of an electromagnetic energy harvester for vehicle suspension", Lei Zuo, have worked on a prototype design of Electromagnetic energy harvester for vehicle suspension. In this paper they have designed, characterized and tested a prototype retrofit regenerative shock absorber

[7] Pei-Sheng Zhang and Lei Zuo, "Energy harvesting, ride comfort, and road handling of regenerative vehicle suspensions", P.Zhang have presented comprehensive assessment of the power that is available for harvesting in the vehicle suspension system and the tradeoff among energy harvesting, ride comfort, and road handing with analysis, simulations and experiments.

III. WORKING OF MAGNETIC SHOCK ABSORBER

In this magnetic shock absorber power generator system is used to generate DC power from shock absorber suspension mechanism. The shock absorber mechanism produces mechanical energy. The mechanical power is converted to electrical energy in the DC power generator using DC Generator. This output is stored into charger as well on battery. In this shock absorber two magnets are placed in a tube. Our magnetic shock absorber works on the basic principle of magnet that "opposite poles attract each other and same poles repel each other". In this both magnets are facing same poles (both magnets are placed facing north and north or south and south). Both magnets are same pole. When the rod moves inside the piston movable magnet move towards the fixed magnet, since both magnets are of same pole repulsion force is created between the magnets. So the movable magnet opposes the rod action and moves the rod up. The piston or cylinder is made up of non-magnetic material. The non-magnetic material will hold the magnet in both the sides. By using this type of shock absorbers the suspension will be more and the impact of vibration is very less compared with the spring loaded shock absorbers. Thus the magnetic shock absorber works.

When the weight of the vehicle increases or vehicle climbs irregular surface, the wheel goes upwards and shock absorber is compressed, at this time the piston moves downwards. The magnets are made closer to each other, due to the increase of weight, the piston rod containing magnet is made to compress to certain extent. At the same time, the stainless steel spring provided is freely inside the shock absorber. The additional support for magnetic shock absorber is provided by a helical coil spring, which was compressed at this stage. So the shocks and vibrations are prevented. When the weight of the vehicle is decreased or it returns to its original position, the shock absorber gets expanded. In this position the piston moves from the bottom to top due to the magnetic flux power of the magnet. The stainless steel spring provided inside the shock absorber made the magnets inside the piston rod to return to its original position slowly. The coil spring return to its original position. Thus the magnetic shock absorber absorbs the shock and vibrations produced while running a vehicle on a irregular road surface.

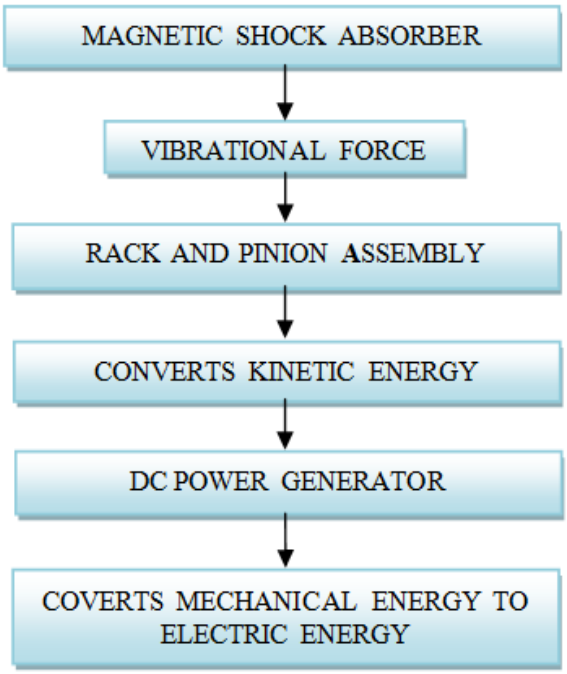

Fig 1:Block diagram of working of Magnetic Shock Absorber

IV. POWER GENERATING MAGNETIC SHOCK ABSORBER

The Power-Generating Magnetic Shock Absorber (PGMSA) converts this kinetic energy into electricity instead of heat through the use of a Linear Motion Magnetic System. Shock absorbers are installed between chassis and wheels to suppress the vibration, mainly induced by road roughness, to ensure ride comfort and road handling. Conventional rotational regenerative shock absorbers translate the suspension oscillatory vibration into bidirectional rotation, using a mechanism like ball screw or rack pinion gears. Figure 2 shows one such an implementation, where the rotary motion is changed by 90 degree with a pair of bevel gears for retrofit. And electricity generated in this mechanism. That electricity is then converted into direct current through a full wave rectifier and stored in the vehicle's batteries.

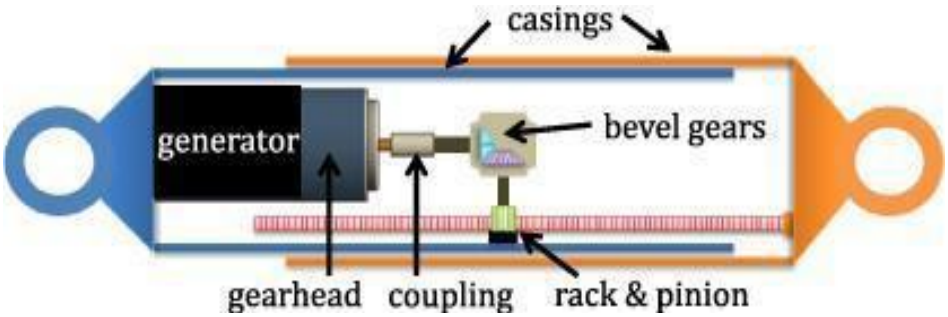

Figure 2: Traditional design of a rack-pinion based power generating shock absorber

The suspension system consist two types of cylinder. One have larger diameter and another have smaller diameter. When suspension is applied, the smaller diameter cylinder moves into the larger diameter cylinder which produces magnetic field due to repetition of movement of cylinders over coils. Then the electric motor converts the magnetic effect into electricity which is to be stored in battery.

V. CONCLUSION

Conventionally, the vibration energy of vehicle suspension is dissipated as heat by shock absorber, which wastes a considerable number of resources. Power generating shock absorber brings hope for recycling the wasted energy. All types of Power Generating Shock Absorber, especially magnetic suspension, and their properties are reviewed in this paper. From the perspective of comprehensive performance including vibration control ability, regenerative efficiency and application reliability with improvement of technology, Power Generating Shock Absorber may become one of promising trends of vehicle industry.

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