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Power Generation by Electromagnetic Suspension System

Aditya Mehra[1], Aman Sahu[2], Ashwini Jha[3], Deepak Singh[4]
[1, 2, 3, 4]*Department of Mechanical Engineering, Oriental Institute of Science & Technology, 4 U.G. Students, , Oriental Institute of Science & Technology, Bhopal, India*

Abstract: ***The main objective of the study is to convert vehicle bump which generated linear motion & vibration, into electrical energy, which is used for used in battery charging. General vehicle shock absorbers are used to simply absorb this energy without converting it to electrical energy. So, here we put forth a way to use this waste of energy and store it for further needs such as vehicle lights, cooling, indicator lights etc. To achieve this, we here use the principles of electromagnetic induction in order to generate electricity from this motion. Our shock absorber is made up of a metal shaft, spring, magnet, coils, base with screws and joints. It uses a coil wound around in particular turning arrangement over the inner beam of the part. We use cylindrical supports in order to minimize friction and ensure smooth generation. The head of the absorber consists of magnets attached to outer core which are aligned with inner core to ensure smooth motion while ensuring efficient generation. This arrangement is fitted with springs in a precise manner so as to achieve the desired motion and magnet coil overlapping which allows for generation of electricity through electromagnetic induction principle.***
Keywords: Electromagnetism, Spring, Magnet, ESS (Electromagnetic Suspension System)

I. INTRODUCTION

A vehicle's suspension system is a mechanical system that supports and communicates with the vehicle's sprung and un-sprung masses. The vehicle body is the sprung mass, while the wheel is the un-sprung mass. It protects the vehicle's body from road noise and aids the wheel's grip on a variety of surfaces. When driving a car, there are bumpy surfaces, acceleration or reductions in driving speed, and steering wheel operations. The sprung mass and the un-sprung mass experience relative shock as a result of this behaviour. The shock is a mechanical power source that can be reused. The suspension system improves road handling for a more comfortable ride for passengers. The most important element is the damper and spring are components of the suspension system. The damper absorbs the vibrations caused by road irregularities and dissipates the energy into the environment. This energy can be harvested using an energy regenerative suspension system, which is a modification of the suspension system. Vibration harvesting on suspension has been studied for nearly two decades. It was a strategy for reducing land vehicle fuel consumption. One of the most critical aspects of mechanical engineering is waste energy regeneration. There have been many studies and experiments on the regenerative suspension system and improvements to the built system, but the implementation is still in its early stages. The power that is available for harvesting on the vehicle suspension system will range from 100 W to 400 W on average. The result was obtained through a 60 mph test on a mid-size vehicle suspension system. The power extracted through the electromagnetic suspension system was affected by road roughness, tyre stiffness, and vehicle driving speed, according to the observation. Suspension stiffness, damping coefficient, and vehicle mass are less sensitive than the other parameters listed. The test was conducted on both good and bad paths. Electromagnetic suspension device: This system recovers kinetic energy from vehicle vibrations by converting it to electrical energy by linear suspension motion. This device has the potential to increase the vehicle's fuel efficiency. For road testing of a sport utility vehicle (SUV) at 20 mph and 30 mph, the results showed that the peak power produced by this system is about 58.2 W and 67.5 W, respectively. The researchers favour the electromagnetic suspension method because it is simple and inexpensive. It attracts researchers because it would increase vehicle efficiencies by replacing the existing passive, semi-active, and hydraulic suspension systems. The vehicle suspension reciprocates as the vehicle passes across an uneven ground surface. The electromagnetic suspension mechanism is controlled by the reciprocating suspension, and the magnet travels upwards and downwards. The magnet's movement cuts the magnetic induction lines, generating electricity in the coil wound along the magnet's movement route.

A. Objectives

1) To offer a maximum efficiency of battery.
2) Enhancing the battery charge transfer rate.
3) Reduce the burden of shock on bumpy roads (Vibrations).

II. METHODOLOGY

A. *Design Concept*

The electromagnetic suspension system is designed using computer-aided design (CAD) software (ESS). This is done to ensure that the part can be manufactured with precise dimensions. Accurate dimensioning aids in the assembly of the ESS components. Several designs are built using CAD tools, but only one is chosen for fabrication. The material used for each part on the ESS varies depending on the purpose of the part. The ESS architecture is a retrofit that does not interfere with the existing vehicle suspension structure. It also operates automatically in the absence of any other power source, allowing the ESS to generate the full amount of electrical energy for vehicle use.

B. *Fabrication*

The ESS is made by drawing in the CAD. The portion is assembled piece by piece. The material used for the ESS is chosen based on the strength required by each part feature. The materials used to make ESS are shown in Table below.

Component	Material
Housing	Teflon
Shaft	Aluminium
Setter	Metal
Magnet Holder	Aluminium
Protective cap	Steel
Bracket	Metal

In order to remove corrosion from the part, aluminium and steel are used because performance reduction and maintenance of ESS increases with Rust. Teflon is used for the housing because it can stand high temperature as reciprocating part will produces friction which causes rise in temperature.

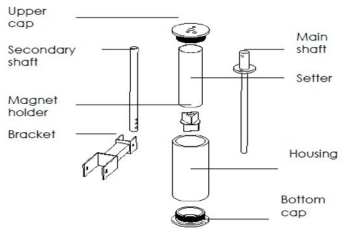

Figure 1 Chosen concept of EReSS

III. CALCULATIONS

On the basis of practical testing with vehicles
When a vehicle is operating at a speed of 40 to 50 km/hr we measure 7 to 10 volts with the help of multi meter.
Voltage Generated (V) = 10 volt
Current Generated (I) = 3.9 amp
As Electrical Power (P) = V x I = 10 x 3.9 = 39 Watts

A. *To Calculate Charging Time For 6 Volt Battery*

This Calculation is for Low Motor Vehicles like bikes.
Charging time =battery current (Ah) / current generated (A)
=4.5 (Ah) /3.9(A) = 1.15 hours
But it was noted that during charging about 35% get loss
=4.5 x 35 /100 =1.575 Ah Charging time
= 4.5 +1.575 /3.9=1.55 hours
By above calculation ,We will say that we can charge a 6 volt battery in 1.55 hours with this suspension, which includes 35 percent loss.

B. To Determine The Time To Charge A 12 Volt Battery

This Calculation is for cars and other heavy vehicles.

Consider that the each suspension is equipped with a suspension system on every side of wheel of vehicles like SUVs , Heavy vehicles like trucks etc.

Since the total voltage generated by this suspension system is 40 volts or more in some cases but we will only consider 40 Volts and 15.6 amps approximately.

Therefore time required to charge a 12 volt, 33 Ah battery is,

Charging Time =Battery current (Ah) / current generated (A)

=33 (Ah)/ 15.6 (A)

=2.115 hours

But it was noted that 35% loss during battery charging

=33 x 35/100

=11.55 (Ah)

Charging time = 33 + 11.55 /15.6 = 2.85 hours

IV. RESULT

With all the calculation made in the project after we measures the power generated by the ESS through multi-meter device.

The multi meter readings are shown in the table:

Speed of vehicle	20-30 Km/Hr	40-50Km/Hr
Voltage produce in 2 wheeler	5-7 Volts	7-10 Volts
Voltage produce in 4 wheeler	20-25 Volts	35-40 Volts
Time for changing of battery considering losses for 2 wheeler	2 hr	1.55 Hr
Time for changing of battery considering losses for 4 wheeler	4.5 Hr	2.85 Hr

V. CONCLUSION

The energy of vibration of the vehicle suspension, which waste a significant number of resources, is discharged as heat by a shock absorber. Shock absorber power generation brings hope for wasteful energy recycling. All types, in particular electromagnetic suspension and its properties, of shock absorber generating power are reviewed in this report. From the view that vibration control capacity, regenerative efficiency and reliability include comprehensive performance. Power generating shock absorbers can be one of the promising trends for the automotive industry with technology improvement. And from the result and calculation basis we can also say that power generation due to suspension system is depend upon the speed of vehical and the condition of the road.

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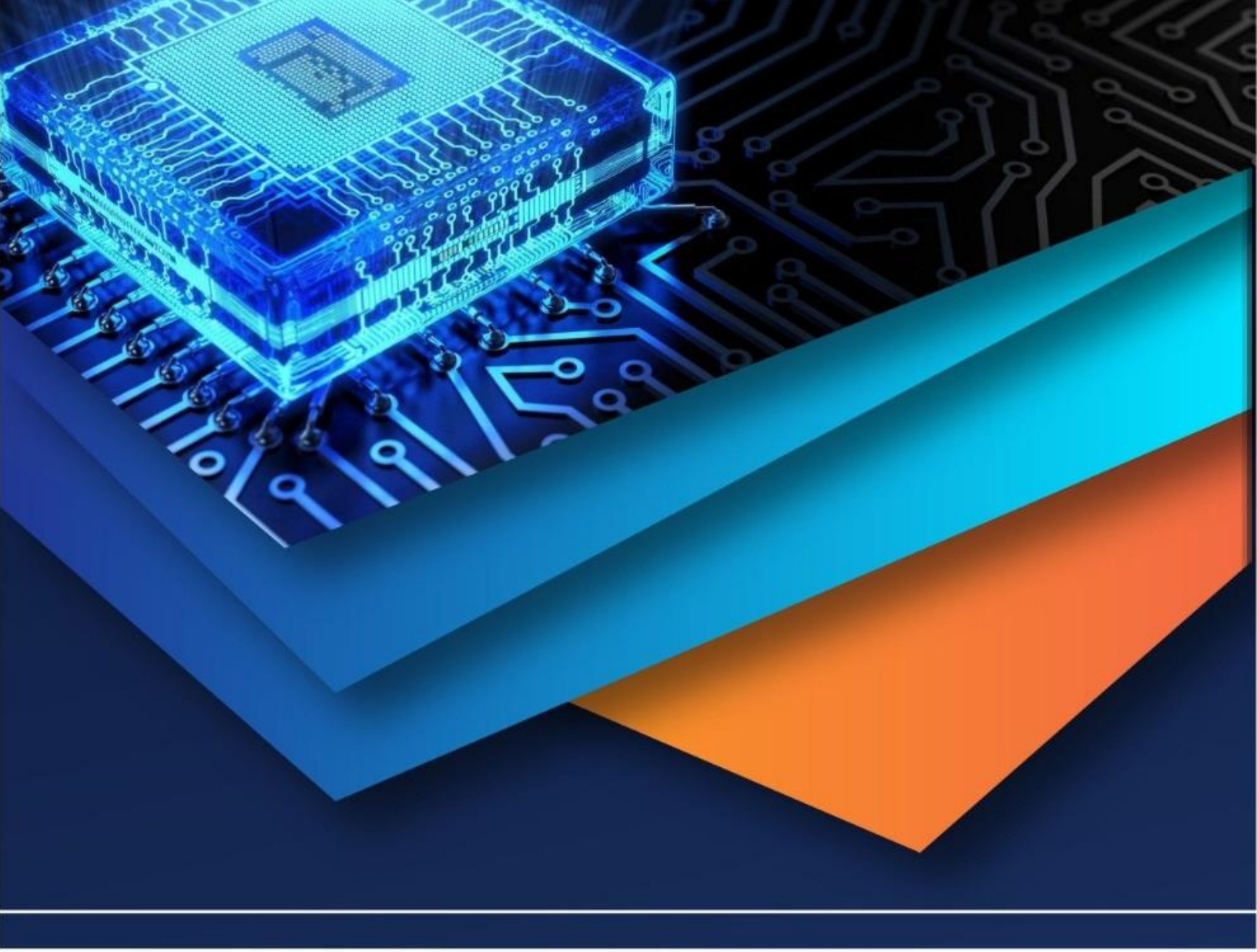

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