



Research Paper

CURRENT PRODUCING SUSPENSION

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when a vehicle moves on the road it encounters many bumps and uneven terrain which results in vertical motion which is often considered undesirable and compensated with a suspension system. A suspension is a system of springs and dampers which allows relative motion between the wheels and the chassis thus neutralising the effect of the vertical force. This motion of the spring is solely used to oppose the vertical force and other possibilities are neglected. Based on Faradays law of EMI “when the magnetic flux linked with a circuit changes an EMF is induced”, a system can be incorporated in the suspension system to make use of the vertical motion of the spring, which if subjected to a magnetic flux will experience a continuous change of field due to the vertical motion and thus generate electricity. The current generated is proportional to the magnetic field and can be enhanced by arranging the dipoles of the magnet and cross doping of varieties of magnets.

Keywords: Suspension system, Relative motion, EMI, Magnetic flux, Magnetic field

INTRODUCTION

Originally electric vehicles came into existence in 1835, after that several experiments were initiated for popularizing the use of electric vehicles. This was till gasoline engines entered in the market; since then up to now the scenario has changed and people prefer gasoline vehicles over electric vehicles. They oversee the disturbances made by gasoline vehicles, rather concentrate on speed, mileage, price. People have forgotten how gasoline prices are ever increasing, the impact of emissions like carbon and nitrates from vehicle have on the environment like pollution and global warming, the higher maintenance necessary

for the vehicle. The fact that engines are merely 24% to 35% efficient as compared to the electric motor which is 90% efficient does not comply with the sales ratio despite the fact that electric vehicles are eco-friendly, and require lesser maintenance.

A problem which comes with electric car is that once charged they run up to limited distance, the new Mahindra Reva e20 for example runs a 100 kms on a full charge; and our country being a little undeveloped doesn't have a single electric car charging station. But what if we can generate current while driving the vehicle which can further propel the vehicle. Generating current inside the vehicle will definitely help to increase the efficiency of the vehicle.

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Suspension is an indispensable unit of the modern automobile.

WHAT IS SUSPENSION SYSTEM?

Suspension is a system made up of a combination of springs and shock absorbers or dampers, which are made up of iron; this system is connected with vehicle wheels and body and the relative motion between them helps achieve a dual goal, increasing the road handling and braking for safety and providing driving pleasure.

USE OF RELATIVE MOTION

The relative motion between the spring and damper can be harnessed to produce a good amount of current.

HOW TO PRODUCE CURRENT?

When the vehicle moves on the road it experiences bumps due to poor quality and unevenness of road which cause spring to move and follows simple harmonic motion relative to the shock absorber; shock absorbers are used to damp the spring motion, if suspension system is surrounded with magnets the relative motion of spring can be used to produce current following the Electromagnetic Laws of motion, and the shock absorber present inside the spring will act as a iron core thus helping in amplifying the current.

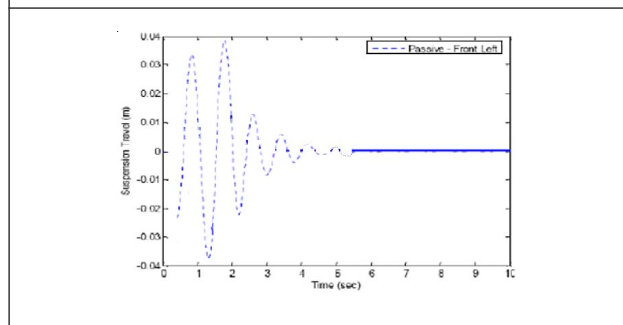
CURRENT PRODUCING POSITIONS

The various instances when the suspension system comes to play are when the CPS kicks in.

1. **Rough roads and rash driving-** While travelling on an uneven road due to various pits and bumps and uneven terrain there is sudden movement in the

suspension which is opposed by the damper and relative motion takes place causing a sudden change in flux and thus helps generate current. Movement of suspension shown in Figure 1

Figure 1: Rough Roads and Rash Diving



2. **Acceleration and braking-** When there is a sudden acceleration or braking the vehicle tends to dip forward or elevate respectively thus actuating the suspension mechanism, again generating current. movement of suspension shown in Figure 2 and Figure 3.

Figure 2: Acceleration

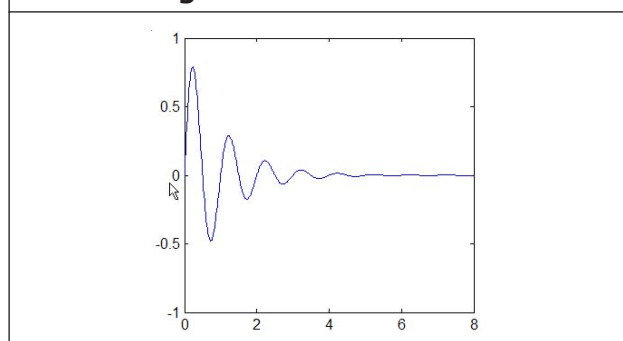
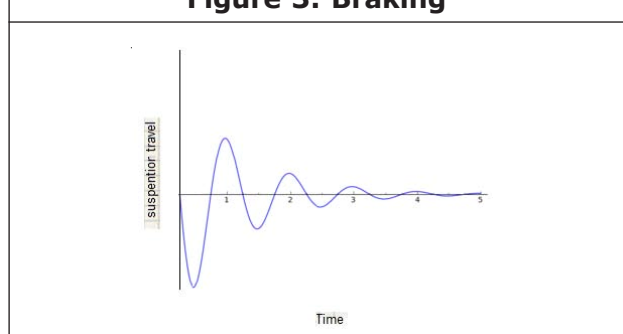


Figure 3: Braking



3. **Speed breakers-** When a vehicle moves over a speed-breaker irrespective of the speed the suspension works to smoothly transfer the car over the breaker, again generating current.
4. **Minute unevenness-** No matter how smooth a road may appear there are certain abruptions on the road which are so minute that they don't meet the eye, never the less the suspension works, again generating current. Movement of suspension shown in Figure 4

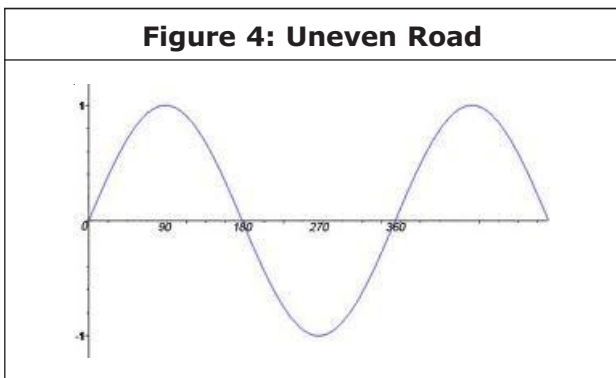


Figure 4: Uneven Road

UTILIZATION OF MAGNET

Magnets can be found in almost any shape and there are innumerable types of magnets available in the market. Simply changing the shape changes the flow of magnetic field. Figure 5 and Figure 6 showing the field of BAR MAGNET and HORSESHOE MAGNET

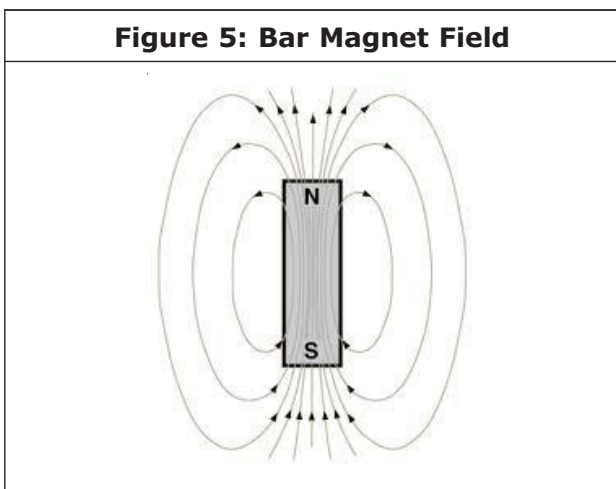


Figure 5: Bar Magnet Field

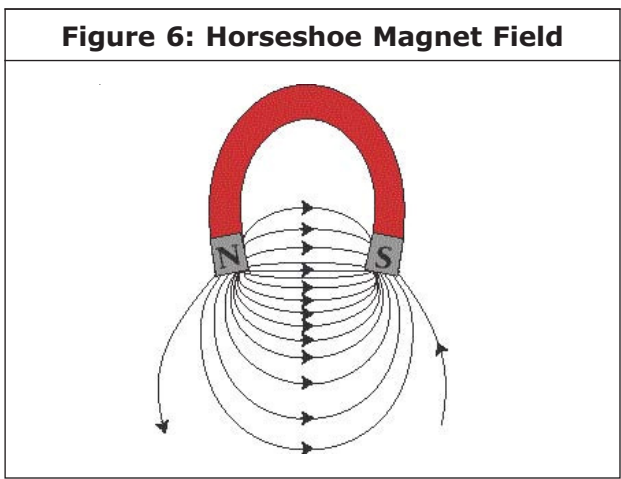


Figure 6: Horseshoe Magnet Field

Magnetic fields in the bar magnet originates from both sides, if this type of magnet is used it will cause many problems like magnetic field from one side face will face the axle and car body, which tends to attract them and may cause dis balancing, this may also interfere in the wire harness which is present all over the vehicle and cause short circuit. It will also attract unnecessary iron particles lying on the road causing disturbance.

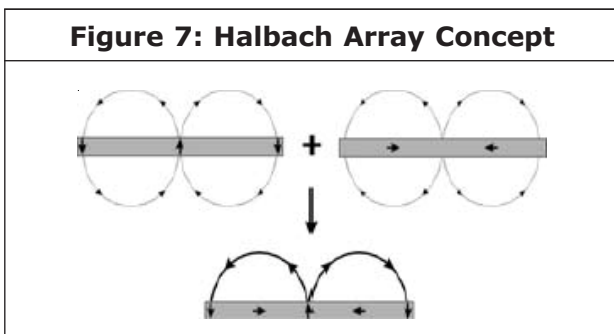
Whereas the magnetic field in a horseshoe magnet is on one side and well concentrated, if such a magnet will surround the suspension it will not cause problems which a bar magnets electric field caused. But a horseshoe magnet will make the arrangement massive and makes assembly of system difficult.

So, the required magnet will be the bar magnets emitting the magnetic field of a horseshoe magnet as it is sleek compare to horseshoe magnet and will not make the arrangement gigantic. Such type of magnets can be created by rearranging the magnetic dipoles.

HALBACH ARRAY

Magnets are made up of dipoles which are present in series as when the magnet is cut in individual several parts each part will have

a separate north and south pole, and if they are attached in different combinations it will tend to give out different types of magnetic fields. The concept is HALBACH ARRAY which says if we rearrange the dipole of the magnet as shown in figure, we can cancel out the magnetic field present on one side of magnet. Figure 7 showing HALBACH ARRAY CONCEPT.



Main advantage of using HALBACH ARRAY is that the field is twice as large on the side on which the flux is confined which means that new magnet will have magnetic field on one side which will have twice the power compare to normal bar magnet therefore with this new magnet a well concentrated magnetic field is developed which doesn't scatter and purely falls on the

suspension; higher the concentration of magnetic field more will be the current produced as magnetic field linking with the spring will get increased.

MAGNET TO BE USED

The market has wide variety of magnets and each magnet has something unique about itself. Of the many magnets suitable for CPS the Neodymium-Iron-Boron magnet stands out. By far the NeFeB is one of the strongest and most durable magnets available. Its capable of carrying loads of almost 50 times its size. Of the main parameters which define a magnet, some are remanence (Br), which measures the strength of the magnetic field; coercivity (Hci), the material's resistance to becoming demagnetized; energy product (BHmax), the density of magnetic energy; and Curie temperature (TC), the temperature at which the material loses its magnetism. As compared to other powerful magnets available in the market Neodymium magnets have higher remanence, much higher coercivity and energy product, but often lower Curie temperature than other types.

Being such a virtuous magnet makes it a good choice for the CPS system.

Table 1: Magnets Details

Magnet	Br (T)	Hci (kA/m)	BHmax (kJ/m3)	TC(°C)
Nd2Fe14B (sintered)	1.0–1.4	750–2000	200–440	310–400
Nd2Fe14B (bonded)	0.6–0.7	600–1200	60–100	310–400
SmCo5 (sintered)	0.8–1.1	600–2000	120–200	720
Sm(Co, Fe, Cu, Zr)7 (sintered)	0.9–1.15	450–1300	150–240	800
Alnico (sintered)	0.6–1.4	275	10–88	700–860
Sr-ferrite (sintered)	0.2–0.4	100–300	10–40	450

Figure 8: CPS Prototype



Figure 10: Voltage Deflection (Positive)



EXPERIMENTAL SETUP

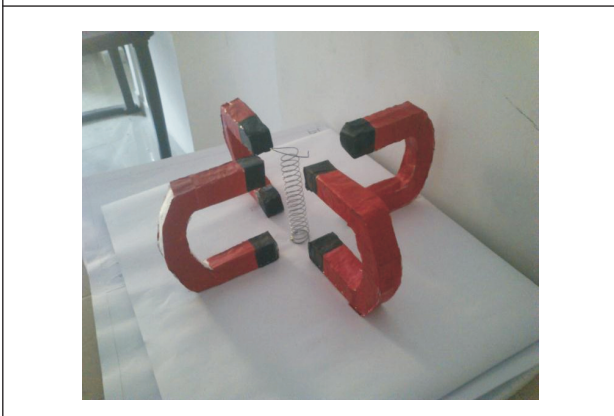
A conducting wire of 2mm diameter is drawn into a spring shape, and surrounded by magnets. Due to unavailability of horse shoe magnets of such big size bar magnets have been put in the upper section is to generate a magnetic field. A multi meter is used to check the production of current; two terminal of multi meter is attached and multi meter is set to voltmeter to check production of voltage. When any external forced is applied to the spring, it is subjected to a movement relative to that of the magnetic field and deflection in current is noticed. The deflection shown is relatively less as magnetic strength is comparatively less.

Figure 11: Voltage Deflection (Negative)



Experimental setup is shown in Figure 9, and voltage reading is shown in Figure 10 and Figure 11.

Figure 9: Experimental Setup



CONCLUSION

The main objective towards this paper is advancing towards sustainable energy. Electric energy is one of the cleanest sources of energy with no emissions making it a noble source. The aim of the CPS is to help the cause of electric vehicles. To increase its sales as the CPS comes with the added advantage of higher efficiency leading to greater mileage and a way to utilize energy which was neglected till now. It was noticed from the experiment that the voltage produce is alternating as there is the relative movement of spring which can be easily converted into the direct current by using full wave rectifier.

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