DESIGN AND DEVELOPMENT OF POWER GENERATION USING SUSPENSION SYSTEM

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Abstract: The power generating electromagnetic suspension system is a system that converts linear reciprocating motion into useful electrical energy. General vehicle's shock absorbers are used to simply absorb mechanical shock. In this paper we would like to put forth a way to use the absorbed kinetic energy and convert it into electrical energy. The electrical power generated may be used to supply the power to vehicle lights, cooling, indicator lights etc. The principle of electromagnetism discovered by Michael Faraday has been employed in order to generate electricity from the motion/movement of the magnet resulted due to absorption of the shock. The shock absorber is made up of a metal shaft, suspension spring, magnet and conducting coils and these are mounted over a structure. When a vehicle is suspended during braking, that linear motion is used to have a to and fro motion of magnet which induces the generation of electromotive force or commonly known as emf as based on electromagnetic principle. This power generation system can be used in all vehicles suspension system and industries where linear or rotary motion (converted to linear reciprocatory motion by slider crank mechanism) can produce electricity by this method. By applying the suspension load manually the power generation can be obtained which can used in rural areas for house hold applications. Our main objective is to utilize excess kinetic energy in vehicles to produce electricity and reduce the power shortages found in remote areas where alternative energy resources are required.

Key words **– Suspension system, Spring, Shock.**

I. INTRODUCTION

Due to the excessive consumption of fossil fuels in the recent years, the vexing issues of climate change is experienced around the planet. So we need alternative sources of energy. Hence researchers around the world are exploring new ways to produce energy. As we know, according to conservation of energy, energy can be converted from one form to another. One of the popular means of energy conversion is mechanical energy to electrical energy. We propose a design a device that converts mechanical energy in automobiles to electrical energy much more efficiently than it has been done before. We plan to work on utilizing of suspended mass of the vehicle and the reciprocating motion of the vehicle resulted due to road bumps. The reciprocating motion of the suspension spring is used to produce electricity. The electrical energy produced is stored in a battery, which can be used further for functioning of the vehicle. This paper focuses on the design and fabrication of the power generating suspension system that can be used in present day vehicles which helps to use the excess kinetic energy. This system can help us to reach even the remote areas where power shortages are common.

II. LITERATURE REVIEW

The literature review provides the information gathered from different research papers. According to Pei Sheng Zhang [1], only 10-20% the fuel energy is used for vehicle mobility. One of the important losses is the energy dissipation in suspension vibration. He uses the rack and pinion along with the suspension in order to convert the reciprocating motion into a rotary motion in order to move the prime mover of the generator to produce electricity. This paper focuses on generating the electrical power by the reciprocating motion of the suspension itself. Electromagnetic suspension system works on the principle of Faraday's law of electromagnetic induction [2]. The shock absorber consists of two tube-like components where a smaller magnetic tube slides inside a larger, hollow coil tube. The coil component is made of copper coils wound around a plastic tube, while the magnetic component is made of ring shaped magnets separated by ring shaped magnetically permeable spacers by using this we can generate electricity.

Pradeep Khande, Gopal Sahu, Prakash Kumar, Ritesh Sharma, Shailendra Bohidar [3]. They studied that the shock absorber is an essential part of the vehicle. The different types of springs are used as a shock absorber in the vehicle such as helical spring, leaf spring, coil spring, etc. The shock absorber is used between the axles and frame of the vehicle. Shock absorbers are an important part of automobile and motorcycle suspensions, aircraft landing gear, and the supports for many industrial machines. Large shock absorbers have also been used in structural engineering to reduce the susceptibility of structures to earthquake damage and resonance.

Zhongjie Li, Lei Zuo, JianKuang, and George Luhrs [4]. This paper deal with energy harvesting shock absorber is able to recover the energy otherwise dissipated in the suspension vibration while simultaneously suppressing the vibration induced by road roughness. It can work as a controllable damper as well as an energy generator. The key component is a unique motion mechanism, which we called "mechanical motion rectifier (MMR)", to convert the oscillatory vibration into unidirectional rotation of the generator.

Rahul Uttamrao Patil, Dr. S.S.Gawade [5]. In this paper, electronic equipment systems are precision system. There are some vibrations and impact in moving vehicles for rough/bumpy road environments. Therefore, shock absorber is significant in protection of electronic equipment in moving vehicles. In this paper, a systematic investigation is done to design or evaluation of a shock absorber and to protect electronic equipment system in harsh vibration-impact environment

III. SPECIFICATION OF PARTS

The image of the suspension springs, copper wire and magnet are shown in Fig.1, Fig.2 and Fig.3 respectively. Also the specification of the suspension springs, copper wire and magnet are shown in Table.1, Table.2 and Table.3 respectively.

Fig.1: Suspension springs

Table.1 Specification of springs

Sl.No	Particular	Specification
1	Spring face length	150 mm
2	Outer diameter	42 mm
3	Inner diameter	37 mm
4	Spring wise diameter	2.5 mm
5	Maximum deflection of spring	40 mm
6	Stiffness	1.22N/mm

Fig.2: Copper wire

Table.2 Specification of copper wire

Sl.No	Particular	Specification
1	Gauge size	20awg
2	Outer diameter	0.81 mm
3	Total length of coil	2.5 m

Fig.3: NdFeB Magnet

Table.3 Specification of magnet

Sl.No	Particular	Specification
1	Type	NdFeB Rare earth, hollow circular type
2	Permanent magnet grade	35
3	Outer diameter	35 mm
4	Inner diameter	18 mm
5	Thickness	8 mm
6	No of magnets used	4
7	Total magnet thickness	32 mm

IV. WORKING PRINCIPLE

Electromagnetic Induction was first discovered way back in the 1830′s by Michael Faraday. Faraday noticed that when he moved a permanent magnet in and out of a coil or a single loop of wire it induces an Electromotive Force or emf, in other words a Voltage, and therefore a current is produced.

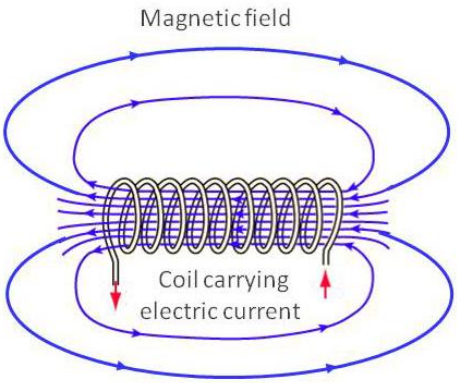

Fig.4: Magnetic field in a coil carrying current

If the wire is wound into a coil, the magnetic field is greatly intensified producing a static magnetic field around itself forming the shape of a bar magnet giving a distinct North and South pole. The magnetic flux developed around the coil is proportional to the amount of current flowing in the coils windings as shown in Fig.4. If additional layers of wire are wound upon the same coil with the same current flowing through them, the static magnetic field strength would be increased.

The magnetic field strength of a coil is determined by the ampere turns of the coil. With more turns of wire within the coil the greater will be the strength of the static magnetic field around it. If were to reverse this idea by disconnecting the current from the coil and instead of a hollow core we placed a bar magnet inside the core of the coil of wire. By moving this bar magnet “in” and “out” of the coil a current would be inducted into the coil by the physical movement of the magnetic flux inside it.

Likewise, if we kept the bar magnet stationary and moved the coil back and forth within the magnetic field an electric current would be induced in the coil. Then by either moving the wire or changing the magnetic field voltage and current will be induced within the coil and this process is known as Electromagnetic Induction. The principle of electromagnetic induction is shown in Fig.5. This is the basic principal of operation of motors, generators and transformers.

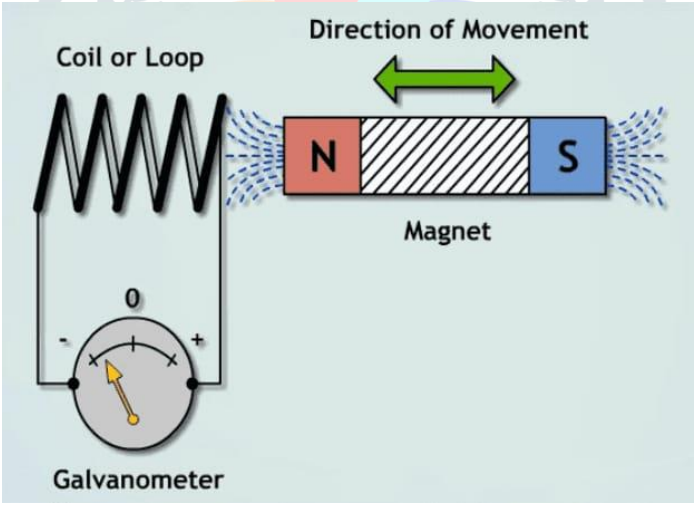

Fig.5: Electromagnetic induction by a moving magnet

Lenz’s law is one of the basic laws in electromagnetic induction for determining the direction of flow of induced currents and is related to the law of conservation of energy. Lenz’s law is derived from Michael Faraday’s law of induction. Lenz’s law states that the direction of the induced current is such that it opposes the change that has induced it. In other words, it is defined as “Effect Opposes the Cause”. According to electromagnetic law of induction, when a relative motion exists between a conductor and a magnetic field, an emf is induced within the conductor. This emf within the conductor of the system causes a circulating current to flow around it and this type of core current is known as an Eddy Current.

V. DESIGN

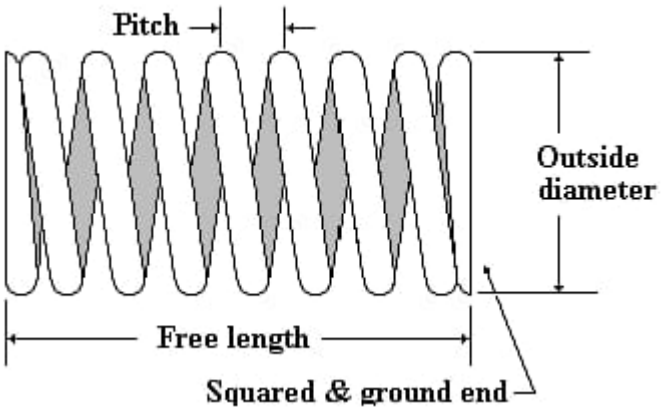

Fig 6: Terminology of spring

- Design of spring

- Outer diameter (Do) = 42mm
- Wire diameter (d) = 2.5mm
- Inner diameter (Di) = 42 - 2.5×2 = 37mm
- To find stiffness (K)

Max deflection (dl) is 40mm under a load (F_{max}) of 6kg,

$K = F_{max}/ (dl)$

$= (6 \times 9.81)/ (40)$

$= 1.47N/mm = 1.47KN/m$

- For safe design max applied load (F) is taken as 5kg
- Number of turns (N) = 11

Spring has 2 inactive turns

Total number of turn (NT) = N + 2 = 13

- Free spring length (L) = solid length + deflection + axial gap = 150mm
- Pitch of spring (p) = (L-d)/N = 10.68mm

- Design of Power generation

- By Faraday's law and lenz's law,

$e = - N.d (\Phi)/dt$

e = emf generated

N = Number of turns

$d (\Phi)/dt$ = rate of change of magnetic flux

Φ = flux (= B. A)

B = Magnetic field

A = cross sectional area of the coil

- When a conductor of length 'l' crossing a magnetic field 'B' at a constant velocity 'v', EMF voltage 'V' is expressed as

$V = v.l.B.\sin(\theta)$

When coil and magnetic field are perpendicular,

$V = v.l.B.\sin(\pi/2) = B.v.l$

The maximum current I is generated by shunt circuit,

$I = V/R$

$= (B.v.l)/R$

Power generated (P)

$P = V. I = V^2/ R$

$= (B^2. v^2.I^2)/R$

VI. RESULT

In this project, the conversion of the mechanical energy into electrical energy is achieved by using electromagnetic induction. The mechanism consists of a copper coil, doughnut shaped NdFeB magnet, suspension spring and an outer protection body comprising all the components. When force is applied on the plate the spring gets compressed and magnet is reciprocating within the copper coil. The result of which the magnetic flux will be affected and an emf is induced in the copper coil. The power produced by this system can be used to light up an LED and also an attempt can be made to improve the efficiency of the vehicle. The system can be installed in the suspension system of the vehicles like two wheeler, four wheeler and any vehicle having suspension system without affecting the function of suspension system. The model is simple in design and economical. The Fabricated model of the power generating suspension system is shown in Fig.7.

Fig 7: Model of the Power Generating Suspension System

VII. CONCLUSION

The power generation from excess kinetic energy, which is dissipated as heat by shock absorbers is harnessed using this system. With proper implement of power generating suspension system, a major impact on Automobile industries can be achieved. If it is desired to achieve more power output, the number of systems can be increased. Finally an alternative energy producing source is designed and developed.

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