EXPERIMENTAL ANALYSIS OF POWER GENERATION USING ELECTROMAGNETIC SUSPENSION SYSTEM

A report submitted to the Department of Mechanical, Sonargaon University of Bangladesh in partial fulfillment of the requirements for the Award of Degree of Bachelor of Science in Mechanical Engineering.

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Abstract

Experimental Analysis of the power generator using electromagnetic suspension system is a system that converts vehicle bump generated linear motion & vibration, into electricity to be show in multi meter. General vehicle shock absorbers are used to simply absorb this energy without converting it to electricity. So here we put forth a way to generate energy and store it for further needs such as vehicle lights, cooling, indicator lights etc. To achieve this we here use the principles of electromagnetism 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 electromagnetism principle. Thus our system puts forward a smart power generation system using electromagnetic suspension system.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 Introduction

The idea for a magnetic shock absorber, makes use of the magnetic repulsion between dipoles to achieve shock absorption. Often when riding on her two-wheeler we used to face some problems while moving on the bumpy road due to its unevenness.it observed that the like pole of two magnets of the same properties and strength repulse each other and they keep constant distance between each other because of their magnetic fields this made her think that if the shock absorber are made of magnets with similar poles facing each other, it may give better performance and no maintenance would be required for the same. In this project two magnets are placed in a piston. One magnet is fixed with piston. Another one is movable, which is connected with rod. With magnets are replaced by air.

Our magnetic shock absorber works on the basic principle of magnet that "opposite poles attract each other and same poles repels 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. Magnetic suspension system is mainly based on the property magnets that like poles of magnets repel each other. This characteristic of magnets is used for suspension work of system. This system also contains spring in between these two magnets to avoid direct contact of two magnets due to overloading. This system finds large number of applications in automobile industry.

In today's world automobile sector has reached its peak. In two wheeler suspensions system used in coil spring is that after some time it becomes not only harder but also reduces cushioning effect. This limitation has overcome by magnetic suspension. The cushioning effect is provided by magnetic suspension is existing for long time. There is one magnet fixed at the top of the inner portion of the cylinder. The second magnet placed at bottom of the inner portion of cylinder that reciprocates up and down due to repulsion. The two magnets fight against each other to achieve the aspect of suspension. Causing the formation of suspension to the vibrations formed in vehicle, which are caused due the road irregularities in order to offer the comfort to both the vehicle assembly and passengers on the vehicle. This system is having the tendency to eliminate the use of conventional suspension system due to its low cost and less maintenance capacity. Fossil fuels are being consumed with very fast rate. Also the cost of fuel is increasing with a very fast rate. So somebody has to work on saving of the fuel consumption. Our aim is to demonstrate how the kinetic energy from the suspension of a car can be utilized to achieve our goal of obtaining maximum energy that would otherwise have gone waste. We propose a design plan that converts the mechanical energy in cars to electrical energy much more efficiently than it has been done before.

The electricity generated will then be used to recharge the car battery for further use for functioning of the car. There is a wide scope for regeneration of energy like regeneration of breaking systematic. We have decided to work on utilization of suspending mass of a vehicle through regeneration system with the help of shock absorber. Shock absorbers are having reciprocating motion in it. Although the reciprocating distance is very low the suspending mass is very high i.e. the mass of total vehicle. When vehicle is on a normal road then also shock absorbers are working due to uneven roads, sudden breaking or sudden acceleration.

So this reciprocating motion of shock absorbers can be converted into rotary motion and through small gearbox attached to alternator of automobile, electricity will be generated when shock absorbers will be reciprocating. In the case of brakes or suspensions, kinetic energy is often released as heat. Friction brakes, which convert kinetic energy to heat, are used in the majority of automobiles. This basically means that when you apply the brakes, a lot of energy is released as heat (Lakshmi, 2017). Regenerative braking is the conversion of kinetic energy generated during braking into a form that can be used right away or stored till later. For most convectional vehicles, the majority of the Kinetic energy converted during friction braking,

between the brake pads & wheels turns into heat which then gets emitted unused into the environment as waste but not when driving a hybrid model or electrical vehicle. Using electric motors, a portion of Kinetic energy can be recovered for reuse. This means using a regenerative braking system, all the Kinetic energy that would have been lost can partially be put right back into the battery. Every automotive suspension has two goals: passenger comfort and vehicle control. Electromagnetic suspension is a system that converts vehicle bump into electrical energy. Its primary function is to reduce effects of vibrations and irregularities on roads. This is achieved with the help of shock absorbers that emit vibrational energy in the form of heat. This heat is the one that this project aims to harvest and convert into electrical power that can then charge the battery. This research proposes a design of a system where the heat lost in the suspension system and brakes combined is extracted, converted into a usable form of electrical energy which can charge batteries. In 1967, the American Motor Car Company (AMC) created an electrical energy regeneration brake for their concept electric car, the AMC Amitron.

Toyota was the first car manufacturer to commercialize RBS technology in their Prius series hybrid cars (Clark, et al,.2011). Since then there has been an evolution in the regenerative braking systems. Modern hybrid cars and EVs make use of an electrical engine to power the car which makes applying regenerative braking very simple and efficient. ZERA launched the first electric car to accelerate adoption of clean energy, it is in sync with Zimbabwe's aspirations of a modernized and mechanized country by 2030. The intent to adopt more electric cars in the country means the need to charge those cars grows. This is a great opportunity to invest in the design of the electromagnetic suspension.

1.2 Objective:

The objectives of this project are:

- To Design and Fabrication of Electromagnetic Suspension System.
- To test the Performance of Fabricated Electromagnetic Suspension System.

1.3 Organization of the Book

This project book consists of Six chapter. The first chapter contains the statement of the introduction, our motivation for the project, objectives of the study, our used methodologies and the project organization. Chapter two contains literature review in details. Chapter three describes the proposed system architecture with component details and the software which we have used for our work. Chapter four contains result and Electrical Calculation.

Chapter five deals with the circuit design, working principle and shows the complete prototype of the project that we have built. In the final chapter, we have discussed the advantages and applications of the project and also about some aspects we had to overcome while doing the project and lastly we gave the conclusion of the book.

CHAPTER 2
LITERATURE REVIEW

2.1 Literature Review

The purpose of this literature review is to go through the main topics of interest. The literature reviews is concerned with design of spur gear, DC generator, design of shaft, selection of bearings & shock absorbed with theoretical and experimental evaluation..

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.[1] Pei Sheng Zhang 2010“Design of Electromagnetic Shock Absorbed for Energy Harvesting from Vehicle Suspensions”, This paper discussed about the different type of suspension system. Also the rank and pinion arrangement in vehicle suspension.[2] Pedro Portela, JoãoSepúlveda, JoãoSenaEsteves 2008 “Alternating current and Direct current Generator”This paper discussed about generators that produce direct current (DC) are called dynamos and the ones that produce alternating current (AC) are called alternators.

The device described in this paper is a generator capable of supplying an electrical load with the desired type of current: alternating current or direct [3] Rahul UttamraoPatil, Dr. S. S. Gawade, “Design and static magnetic analysis of electromagnetic regenerative shock absorber” Electronic equipment systems are precision system. There are some vibrations and impact in moving vehicles for road environments.[4] Therefore, shock absorber is significant in protection of electronic equipment in moving vehicles. In this paper a systematic investigation to design or evaluation of a shock absorber for protection of electronic equipment system in harsh vibration-impact environment.

Bin Yang, Chengkuo Lee, Wenfeng Xiang, Jin Xie, Johnny Han He, Rama Krishna Kotlanka, Siew Ping Low, Hanhua Feng 2008 Bin Yang (2008) proposed a multiple frequency energy regenerative technique based on the electromagnetic method. The major advantage of this device is it is cost effective and competent of regenerating more power from vibrations of multiple frequency.

Lei Zuo, Brian Scully, Jurgen Shestani and Yu Zhou 2010 Lei Zuo and Zhou (2010) proposed a constituent energy harvesting damper. A half scale precursor of a quadruple-state linear generator was refined. The half-scale precursor harvested 2 to 8 W of energy. The wave shapes of the regenerated voltage will depend on excitation frequency, amplitude and equilibrium position.

Peng Li and Lei Zuo 2013 Li and Zuo (2013) proposed a comparison between rotary electromagnetic regenerative shock absorbers with and without Mechanical Motion Rectifier(MMR).A quarter-car model was used to evaluate the suspension performance of MMR, non-MMR and conventional shock absorbers. The result exhibited that the MMR based electromagnetic damper is capable of achieving performances.

Zhongjie Li, Lei Zuo, George Luhrs, Liangjun Lin, and Yi-xian Qin 2013 Zhongjie Li and xian Qin (2013) proposed a retro fit rack and pinion based electromagnetic energy harvesting damper system which can produce electric energy from the suspension vibration of vehicles due to irregular road profile. The model being fed sinusoidal displacement was examined on a test machine. The output shows that the damping co-efficient depends upon external electrical resistances. Hence, the energy harvesting shock absorber can be used as a controllable damper.

Shankar Singh and Nitin Vijay Satpute 2015 Singh and Satpute (2015) proposed the design of a shock absorber with a linear generator and fluid damper. The contrived damper employs hydraulic amplification to improve the power output and henceforth achieve an effective damping co-efficient .This damper shows consistent damping performance and improved fail-safe characteristics.

2.2 Suspension System

The automobile chassis is mounted on the axles, not direct but through some form of springs. This is done to isolate the vehicle body from the road shocks which may be in the form of bounce, pitch, roll or frame and body. All the parts which perform the function of isolating the automobile from the road shocks sway. These tendencies give rise to an uncomfortable ride and also cause additional stress in the automobile are collectively called a suspension system. It includes the springing device used and various mountings for the same. Broadly speaking, suspension system consists of a spring and a damper. The energy of road shock causes the spring to oscillate. These oscillations are restricted to a reasonable level by the damper, which is more commonly called a shock absorber.

Shock Absorber

A Shock Absorber is a mechanical device designed to smooth out or damp shock impulse, and convert kinetic energy to another form of energy (usually thermal energy, which can be easily dissipated). It is a type of dashpot. A shock absorber is a device which convert mechanical energy into thermal energy. The energy transformation occurs as the shock absorbers fluid medium is forced through orifice at high velocity. Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs.

An automobile shock absorber contains spring-loaded check valves and orifices to control the flow of oil through an internal piston. One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most shock absorbers, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid heats up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of shock absorbers, such as electromagnetic types, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion vehicles on uneven roads

In a vehicle, shock absorbers reduce the effect of travelling over rough ground, leading to improved ride quality and vehicle handling.

While shock absorbers serve the purpose of limiting excessive suspension movement, their intended sole purpose is to damp spring oscillations. Shock absorbers use valving of oil and gasses to absorb excess energy from the springs. Spring rates are chosen by the manufacturer based on the weight of the vehicle, loaded and unloaded.

Some people use shocks to modify spring rates but this is not the correct use. Along with hysteresis in the tire itself, they damp the energy stored in the motion of the unspring weight up and down. Effective wheel bounce damping may require tuning shocks to an optimal resistance. Spring-based shock absorbers commonly use coil springs or leaf springs, though torsion bars are used in torsional shocks as well. Ideal springs alone, however, are not shock absorbers, as springs only store and do not dissipate or absorb energy. Vehicles typically employ both hydraulic shock absorbers and springs or torsion bars.

In this combination, "shock absorber" refers specifically to the hydraulic piston that absorbs and dissipates vibration.

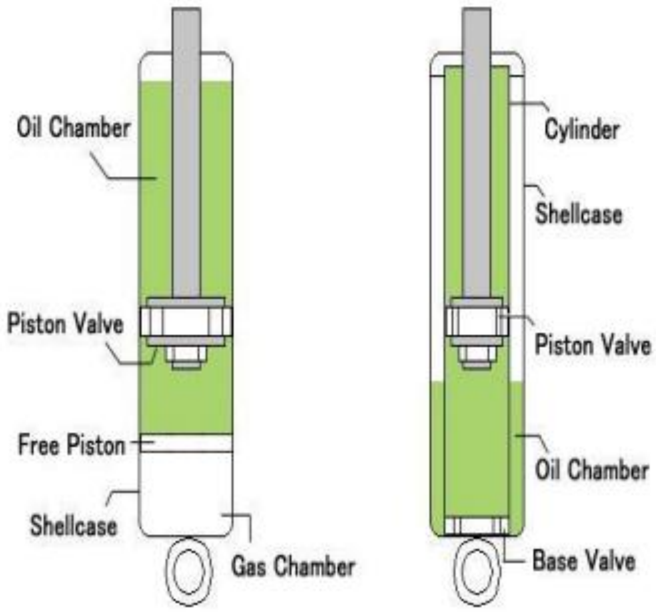


Figure 2.1 : Mono Tube And Twin Tube Shock Absorber

Types of Shock Absorber

There are two types of shock absorber are given below.

A) Air Shock Absorber

B) Damper Shock Absorber

1) Mono Tube Shock Absorber

2) Twin Tube Shock Absorber

A) Air Shock Absorber
   Air shock absorber consists of an air chamber, an iron piston and a fluid.

B) Damper Shock Absorber
   A damper shock absorber consists of a single chamber or two chamber, it may be fluid field or filled with air. It is commonly used to absorb the shock during the linear motion of a vehicle

1) Mono Tube Shock Absorber

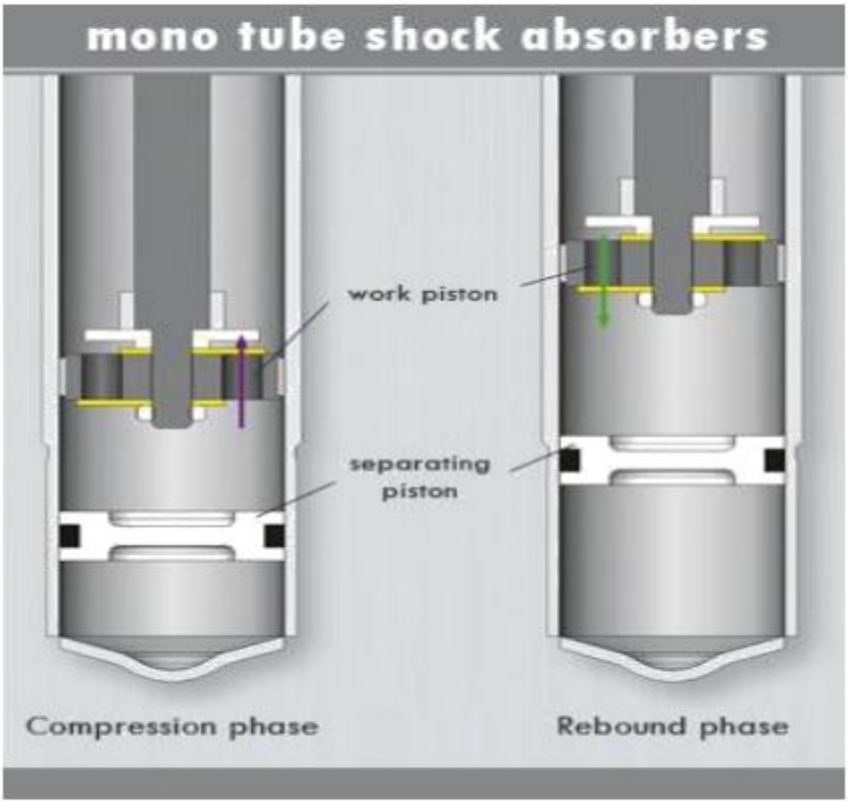


Figure 2.2: Mono Tube Shock Absorber

The mono tube damper consists of single tube with two valves. It is mostly oil filled and used in larger vehicles. When the damper compresses when of the valve gets opened and when it extends the other valve gets open and the first one closes. The amount of the fluid released depends on the speed of the bumps it gets while moving. If it receives low speed small bumps the larger vents get opened and there is large amount of fluid is released. On the other hand, if gets high speed strong bumps the smaller vent gets opened and a small amount of oil is released.

2) Twin Tube Shock Absorber

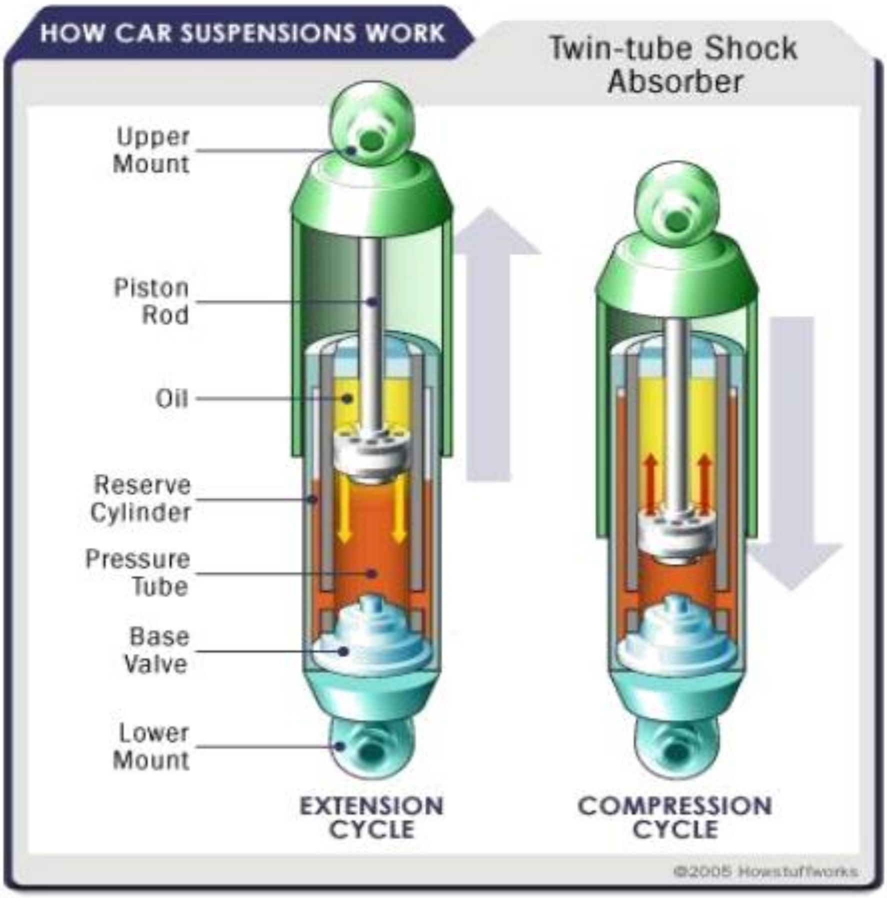


Figure 2.3: Twin Tube Shock Absorber

Also known as a "two-tube" shock absorber, this device consists of two nested cylindrical tubes, an inner tube that is called the "working tube" or the "pressure tube", and an outer tube called the "reserve tube". At the bottom of the device on the inside is a compression valve or base valve. When the piston is forced up or down by bumps in the road, hydraulic fluid moves between different chambers via small holes or "orifices" in the piston and via the valve, converting the "shock" energy into heat which must then be dissipated.

Electromagnetic suspension (**EMS**) is the magnetic levitation of an object achieved by constantly altering the strength of a magnetic field produced by electromagnets using a feedback loop. In most cases the levitation effect is mostly due to permanent magnets as they don't have any power dissipation, with electromagnets only used to stabilize the effect. According to Earnshaw's Theorem a paramagnetically magnetized body cannot rest in stable equilibrium when placed in any combination of gravitational and magnetostatic fields. In

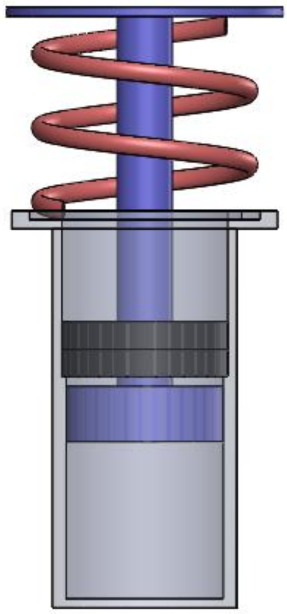


Figure 2.4 : Power Generation using Electromagnetic Suspension 3d image.

These kinds of fields an unstable equilibrium condition exists. Although static fields cannot give stability, EMS works by continually altering the current sent to electromagnets to change the strength of the magnetic field and allows a stable levitation to occur. In EMS a feedback loop which continuously adjusts one or more electromagnets to correct the object's motion is used to cancel the instability. Many systems use magnetic attraction pulling upwards against gravity for these kinds of systems as this gives some inherent lateral stability, but some use a combination of magnetic attraction and magnetic repulsion to push upwards. Magnetic levitation technology is important because it reduces energy consumption, largely reduces friction. It also avoids wear and has very low maintenance requirements. The application of magnetic levitation is most commonly known for its role in Maglev trains.

History

electrostatic field cannot levitate at stable equilibrium under the influence of electric forces alone".[1] Likewise, due to limitations on permittivity, stable suspension or levitation cannot be achieved in a static magnetic field with a system of permanent magnets or fixed current electromagnets. Braunbeck's extension (1939) states that a system of permanent magnets must also contain diamagnetic material or a superconductor in order to obtain stable, static magnetic levitation or suspension.[2] Emile Bachelet applied Earnshaw's theorem and the Braunbeck extension and stabilized magnetic force by controlling current intensity and turning on and off power to the electromagnets at desired frequencies.

He was awarded a patent in March 1912 for his "levitating transmitting apparatus" (patent no. 1,020,942).[3] His invention was first intended to be applied to smaller mail carrying systems but the potential application to larger train-like vehicles is certainly apparent.

In 1934 Hermann Kemper applied Bachelet's concept to the large scale, calling it "monorail vehicle with no wheels attached." He obtained Reich Patent number 643316 for his invention and is also considered by many to be the inventor of maglev. In 1979 the Trans rapid electromagnetically suspended train carried passengers for a few months as a demonstration on a 908 m track in Hamburg for the first International Transportation Exhibition (IVA 79). The first commercial Maglev train for routine service was opened in Birmingham, England in 1984, using electromagnetic suspension, and a linear induction motor for propulsion.

Background:

Electromagnets

When a current passes through a wire, a magnetic field around that wire is generated. The strength of the generated magnetic field is proportional to the current through the wire. When a wire is coiled, this generated magnetic field is concentrated through the center of the coil.

The strength of this field can be greatly increased by placing a ferromagnetic material in the center of the coil. This field is easily manipulated by passing a varying current in the wire. Therefore, a combination of permanent magnets with electromagnets is an optimal arrangement for levitation purposes.[1]

Feedback

The position of the suspended object can be detected optically or magnetically, other schemes may sometimes be used. The feedback circuit controls the electromagnet to try to keep the suspended object at the correct position. However, simply controlling the position usually leads to instability, due to the small time delays in the inductance of the coil and in sensing the position. In practice then, the feedback circuitry must use the change of position over time to determine and damp the speed.

Application

Maglev (magnetic levitation) is a transportation system in which a vehicle is suspended on a guiding rail by the principle of electromagnetic suspension. Maglev has the advantages of being quieter and smoother than wheeled transportation's due to the elimination of much of the physical contact between wheels and track. Since Maglev requires a guiding rail, it is mostly used in railed transport systems like trains. Since the first commercial Maglev train was opened in Birmingham, England in 1984, other commercial EMS Maglev train systems, such as the M-Bahn and the Trans rapid have also been put into limited use. (Maglev trains based on electrodynamic suspension technology have also been developed and deployed.) With the possible exception of the 30.5 km Shanghai Maglev Train, no major long-distance EMS Maglev routes have been built.

Active magnetic bearing

An active magnetic bearing (AMB) works on the principle of electromagnetic suspension and consists of an electromagnet assembly, a set of power amplifiers which supply current to the electromagnets, a controller, and gap sensors with associated electronics to provide the feedback required to control the position of the rotor within the gap. These elements are shown in the diagram. The power amplifiers supply equal bias current to two pairs of electromagnets on opposite sides of a rotor. This constant tug-of-war is mediated by the controller which offsets the bias current by equal but opposite perturbations of current as the rotor deviates by a small amount from its center position. The gap sensors are usually inductive in nature and sense in a differential mode. The power amplifiers in a modern commercial application are solid state devices which operate in a pulse-width modulation (PWM) configuration. The controller is usually a microprocessor or DSP.

CHAPTER 3

METHODOLOGY & WORKING PRINCIPLE

3.1 Construction:

We used magnets, springs, copper coils and inner rods to make this project. The main purpose of our project is to generate power by cutting magnetic flux. This makes it possible to generate power from cars or large mill factory equipment. Below is a demo structure of it-

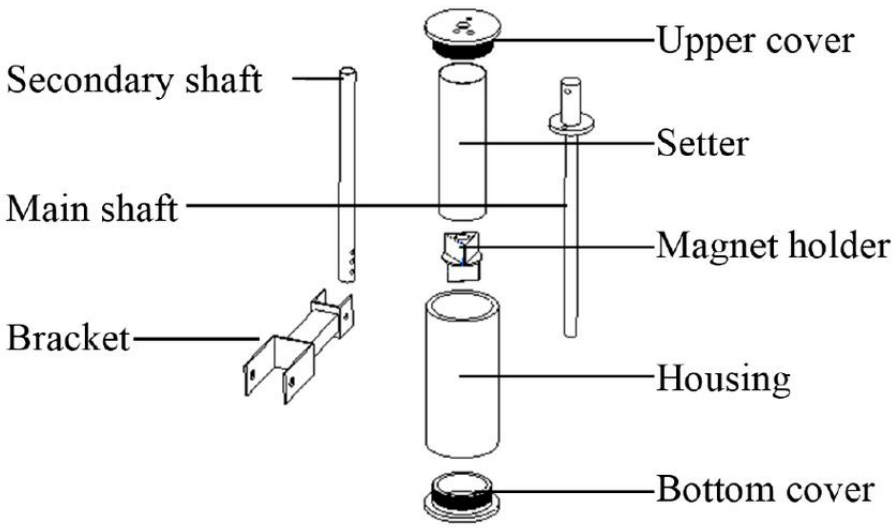


Figure 3.1: Construction of our Project.

3.2 Feature of magnetic suspension:

Some of the main features of electromagnetic suspensions are:

1) It prevents the road shocks from being transmitted to the vehicle parts, thereby providing suitable riding and cushioning effect to the occupants.
2) Keeps the vehicle stable while in motion by providing good road holding during driving, cornering and braking.
3) Provides safe vehicle control and free of irritating vibrations and reduce wear and tear.
4) Easy to design and modify the design (if according to any automobile's specifications.

5) It provides you the maximum safety and comfort ability when compared to the other conventional suspension systems

3.3 Overview Modern Suspension System

When people think of automobile performance, they normally think of horse power, torque and zero-to- 60 acceleration. But all of the power generated by a piston engine is useless if the driver can't control the car. That's why automobile engineers turned their attention to the suspension system almost as soon as they had mastered the four-stroke internal combustion engine. The job of a car suspension is to maximize the friction between the tires and the road surface, to provide steering stability with good handling and to ensure the comfort of the passengers. If a road were perfectly flat, with no regularities, suspensions wouldn't be necessary. But roads are far from flat. It's these imperfections that apply forces to the wheels. According to Newton's laws of motion, all forces have both magnitude and direction. A bump in the road causes the wheel to move up and down perpendicular to the road surface. The magnitude, of course, depends on whether the wheel is striking a giant bump or a tiny speck. Either way, the car wheel experiences a vertical acceleration as it passes over an imperfection.

3.4 Methodology

Our Methodology of this Project:

- The basic principles of electromagnetic induction and levitation can be effectively applied to electricity generation.
- Measure and evaluate the effectiveness of electromagnetic suspension systems in converting mechanical energy into electrical energy.
- Evaluate the system's power generation capabilities, including its ability to produce sufficient amounts of power. Measure key performance indicators such as voltage, current and output power under various operating conditions.
- Collecting the all components/materials for construct the system.
- Finally, we made this system & checked it finally that working very well.

3.5 Block Diagram:

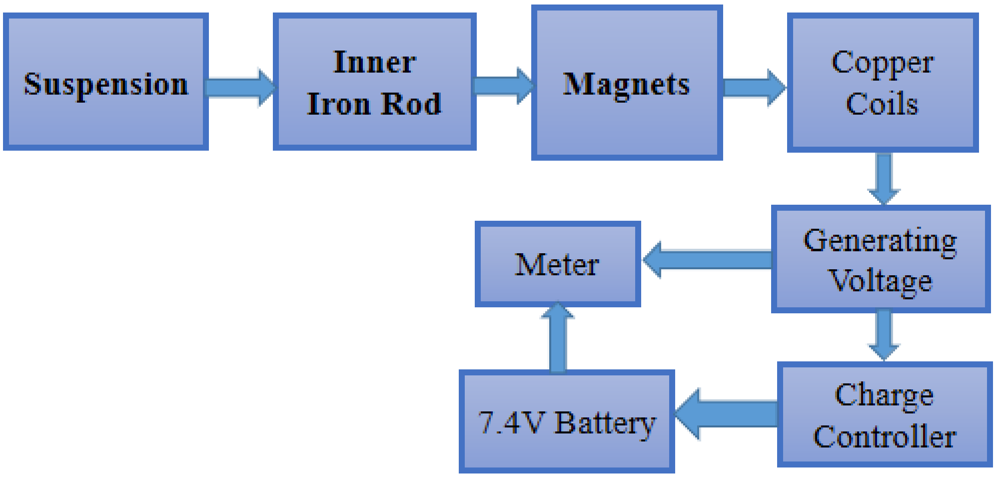


Figure 3.2: Block Diagram of Power Generation using Electromagnetic Suspension

3.6 Suspension

Suspension system is designed to provide a smooth and comfortable ride by absorbing shocks and vibrations from the road. It typically includes springs and dampers (shock absorbers). As the vehicle moves along the road, it encounters bumps, imperfections, and vibrations. These movements cause the car's body to bounce and sway.

The car body moves up and down due to road irregularities, the magnets in the suspension system also move within their coils. Relative motion between magnets and coils generates a varying magnetic field, which induces an electrical current in the coils through electromagnetic induction.

The induced electrical current can be harnessed and directed into an electrical storage system, such as a battery or a supercapacitor. Electrical power generated through this process can be used to charge the car's battery, power onboard electronics, or even feed back into the vehicle's electrical system.

3.7 Inner Rod

The inner rod could serve as a structural element within the suspension system, providing support and stability to other components. It may help maintain the alignment and positioning of the magnets and coils, ensuring they remain properly spaced and aligned. The inner rod designed to transmit the mechanical motion or vibrations from the vehicle's suspension to the components involved in power generation. It might connect the vehicle's chassis or body to the electromagnetic components, allowing for the transfer of motion

Spring (Device)

A **spring** is an elastic object that stores mechanical energy. Springs are typically made of spring steel. There are many spring designs. In everyday use, the term often refers to coil springs.

When a conventional spring, without stiffness variability features, is compressed or stretched from its resting position, it exerts an opposing force approximately proportional to its change in length (this approximation breaks down for larger deflections). The *rate* or *spring constant* of a spring is the change in the force it exerts, divided by the change in deflection of the spring. That is, it is the gradient of the force versus deflection curve. An extension or compression spring's rate is expressed in units of force divided by distance, for example or N/m or lbf/in. A torsion spring is a spring that works by twisting; when it is twisted about its axis by an angle, it produces a torque proportional to the angle. A torsion spring's rate is in units of torque divided by angle, such as N·m/rad or ft·lbf/degree. The inverse of spring rate is compliance, that is: if a spring has a rate of 10 N/mm, it has a compliance of 0.1 mm/N. The stiffness (or rate) of springs in parallel is additive, as is the compliance of springs in series.

Figure 3.3: Spring (Device)

Types:

Springs can be classified depending on how the load force is applied to them:

- **Tension/extension spring** – the spring is designed to operate with a tension load, so the spring stretches as the load is applied to it.
- **Compression spring** – is designed to operate with a compression load, so the spring gets shorter as the load is applied to it.
- **Torsion spring** – unlike the above types in which the load is an axial force, the load applied to a torsion spring is a torque or twisting force, and the end of the spring rotates through an angle as the load is applied.
- **Constant spring** – supported load remains the same throughout deflection cycle
- **Variable spring** – resistance of the coil to load varies during compression
- **Variable stiffness spring** – resistance of the coil to load can be dynamically varied for example by the control system, some types of these springs also vary their length thereby providing actuation capability as well.

They can also be classified based on their shape:

- **Flat spring** – this type is made of a flat spring steel.
- **Machined spring** – this type of spring is manufactured by machining bar stock with a lathe and/or milling operation rather than a coiling operation. Since it is machined, the spring may incorporate features in addition to the elastic element. Machined springs can be made in the typical load cases of compression/extension, torsion, etc.
- **Serpentine spring** – a zig-zag of thick wire – often used in modern upholstery/furniture.
- **Garter spring** – A coiled steel spring that is connected at each end to create a circular shape.

3.8 Magnet:

A **magnet** is a material or object that produces a magnetic field. This magnetic field is invisible but is responsible for the most notable property of a magnet: a force that pulls on other ferromagnetic materials, such as iron, steel, nickel, cobalt, etc. and attracts or repels other magnets.

A **permanent magnet** is an object made from a material that is magnetized and creates its own persistent magnetic field. An everyday example is a refrigerator magnet used to hold notes on a refrigerator door. Materials that can be magnetized, which are also the ones that are strongly attracted to a magnet, are called ferromagnetic (or ferry magnetic). These include the elements iron, nickel and cobalt and their alloys, some alloys of rare-earth metals, and some naturally occurring minerals such as lodestone. Although ferromagnetic (and ferrimagnetic) materials are the only ones attracted to a magnet strongly enough to be commonly considered magnetic, all other substances respond weakly to a magnetic field, by one of several other types of magnetism.

Figure 3.4: Magnet

Magnetic Field:

The magnetic flux density is a vector field. The magnetic field vector at a given point in space is specified by two properties:

1. Its direction, which is along the orientation of a compass needle.
2. Its magnitude (also called strength), which is proportional to how strongly the compass needle orients along that direction.

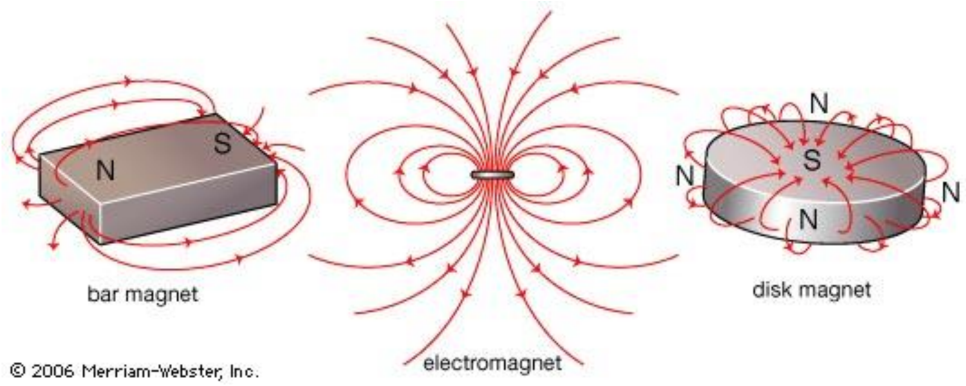


Figure 3.5: Magnetic Field

Magnetization:

The magnetization of a magnetized material is the local value of its magnetic moment per unit volume, usually denoted **M**, with units A/m. It is a vector field, rather than just a vector (like the magnetic moment), because different areas in a magnet can be magnetized with different directions and strengths (for example, because of domains, see below). A good bar magnet may have a magnetic moment of magnitude 0.1 $A{\cdot}m^2$ and a volume of 1 cm^3, or 1×10^{-6} m^3, and therefore an average magnetization magnitude is 100,000 A/m. Iron can have a magnetization of around a million amperes per meter. Such a large value explains why iron magnets are so effective at producing magnetic fields.

Electromagnets:

An electromagnet, in its simplest form, is a wire that has been coiled into one or more loops, known as a solenoid. When electric current flows through the wire, a magnetic field is generated. It is concentrated near (and especially inside) the coil, and its field lines are very similar to those of a magnet. The orientation of this effective magnet is determined by the right hand rule. The magnetic moment and the magnetic field of the electromagnet are proportional to the number of loops of wire, to the cross-section of each loop, and to the current passing through the wire. If the coil of wire is wrapped around a material with no special magnetic properties (e.g., cardboard), it will tend to generate a very weak field. However, if it is wrapped around a soft ferromagnetic material, such as an iron nail, then the net field produced can result in a several hundred- to thousand-fold increase of field strength.

Field of Magnet:

Far away from a magnet, the magnetic field created by that magnet is almost always described (to a good approximation) by a dipole field characterized by its total magnetic moment. This is true regardless of the shape of the magnet, so long as the magnetic moment is non-zero. One characteristic of a dipole field is that the strength of the field falls off inversely with the cube of the distance from the magnet's center. Closer to the magnet, the magnetic field becomes more complicated and more dependent on the detailed shape and magnetization of the magnet. Formally, the field can be expressed as a multi pole expansion: A dipole field, plus a quadrupole field, plus an octupole field, etc.

At close range, many different fields are possible. For example, for a long, skinny bar magnet with its north pole at one end and south pole at the other, the magnetic field near either end falls off inversely with the square of the distance from that pole

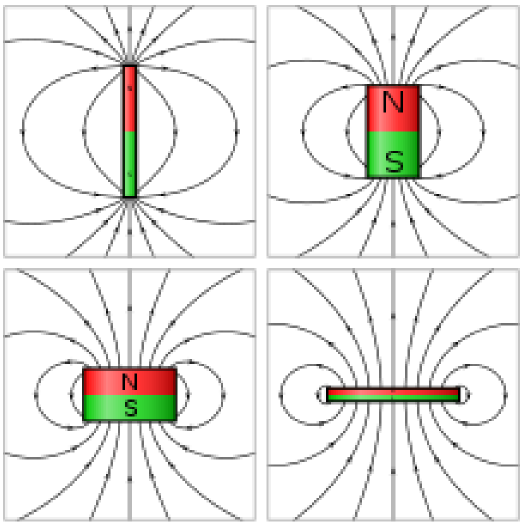


Figure 3.6: Field line of cylindrical magnet

Magnetic Flux:

Magnetic flux is a measurement of the total magnetic field which passes through a given area. It is a useful tool for helping describe the effects of the magnetic force on something occupying a given area. The measurement of magnetic flux is tied to the particular area chosen.

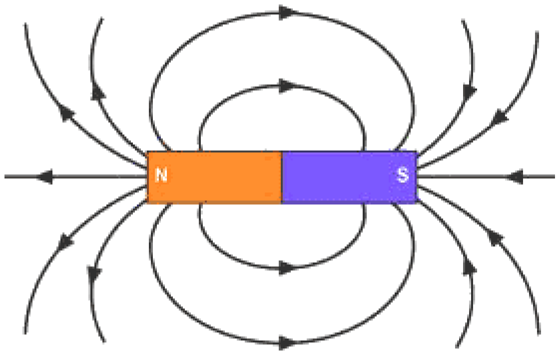


Figure 3.7: Magnetic Flux Density

Description:

The magnetic interaction is described in terms of a vector field, where each point in space is associated with a vector that determines what force a moving charge would experience at that point (see Lorentz force). Since a vector field is quite difficult to visualize at first, in elementary physics one may instead visualize this field with field lines. The magnetic flux through some surface, in this simplified picture, is proportional to the number of field lines passing through that surface (in some contexts, the flux may be defined to be precisely the number of field lines passing through that surface; although technically misleading, this distinction is not important). The magnetic flux is the *net* number of field lines passing through that surface; that is, the number passing through in one direction minus the number passing through in the other direction (see below for deciding in which direction the field lines carry a positive sign and in which they carry a negative sign). In more advanced physics, the field line analogy is dropped and the magnetic flux is properly defined as the surface integral of the normal component of the magnetic field passing through a surface.

3.9 Electromagnetic Coil

An electromagnetic coil is an electrical conductor such as a wire in the shape of a coil, spiral or helix. Electromagnetic coils are used in electrical engineering, in applications where electric currents interact with magnetic fields, in devices such as electric motors, generators, inductors, electromagnets, transformers, and sensor coils. Either an electric current is passed through the wire of the coil to generate a magnetic field, or conversely, an external time-varying magnetic field through the interior of the coil generates an EMF (voltage) in the conductor.

A current through any conductor creates a circular magnetic field around the conductor due to law. The advantage of using the coil shape is that it increases the strength of the magnetic field produced by a given current. The magnetic fields generated by the separate turns of wire all pass through the center of the coil and add (superpose) to produce a strong field there. The more turns of wire, the stronger the field produced. Conversely, a changing external magnetic flux induces a voltage in a conductor such as a wire, due to Faraday's law of induction. The induced voltage can be increased by winding the wire into a coil because the field lines intersect the circuit multiple times.

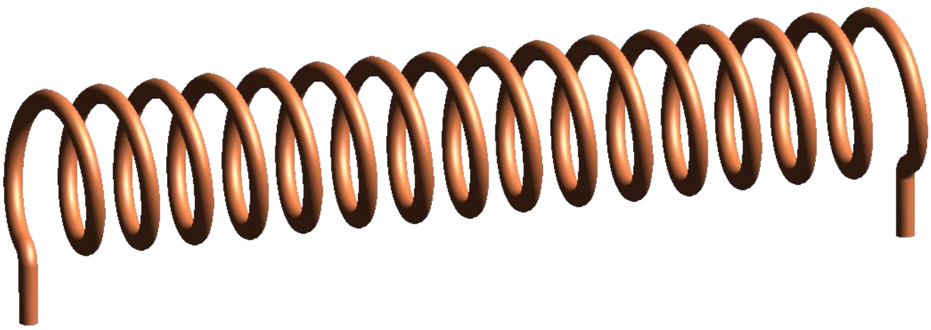


Figure 3.8: Coil Winding

3.10 Generating Voltage

The power generator electromagnetic suspension system is a system that converts vehicle bump generated linear motion & vibration, into electricity to be used in battery charging. General vehicle shock absorbers are used to simply absorb this energy without converting it to electricity. To achieve this, we here use the principles of electromagnetism in order to generate electricity from this motion.

3.11 Multi Meter

A multimeter is a measuring instrument that can measure multiple electrical properties. A typical multimeter can measure voltage, resistance, and current, in which case it is also known as a volt-ohm-millimeter (VOM).

Analog multimeter uses a micrometer with a moving pointer to display readings. Digital multimeter (DMM, DVOM) has numeric displays and have made analog multimeter obsolete as they are cheaper, more precise, and more physically robust than analog multimeter.

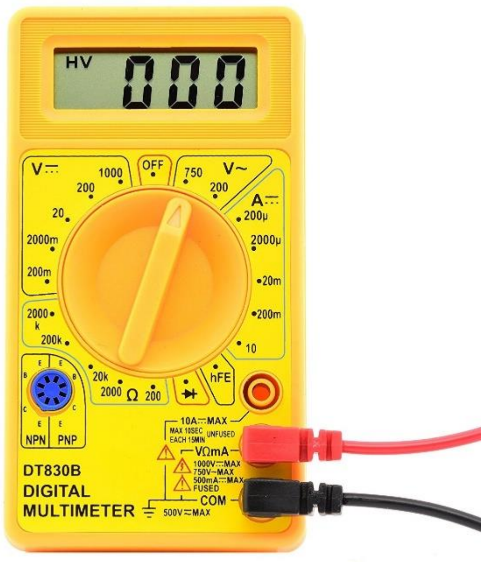


Figure 3.9: Multi Meter

Operation:

A multimeter is the combination of a DC voltmeter, AC voltmeter, ammeter, and ohmmeter. An UN-amplified analog multimeter combines a meter movement, range resistors and switches; VTVMs are amplified analog meters and contain active circuitry.

For an analog meter movement, DC voltage is measured with a series resistor connected between the meter movement and the circuit under test. A switch (usually rotary) allows greater resistance to be inserted in series with the meter movement to read higher voltages. The product of the basic full-scale deflection current of the movement, and the sum of the series resistance and the movement's own resistance, gives the full-scale voltage of the range.

As an example, a meter movement that required 1 mA for full-scale deflection, with an internal resistance of 500 Ω, would, on a 10 V range of the multi meter, have 9,500 Ω of series resistance.[8]

For analog current ranges, matched low-resistance shunts are connected in parallel with the meter movement to divert most of the current around the coil. Again, for the case of a hypothetical 1 mA, 500 Ω movement on a 1 A range, the shunt resistance would be just over 0.5 Ω.

Moving coil instruments can respond only to the average value of the current through them. To measure alternating current, which changes up and down repeatedly, a rectifier is inserted in the circuit so that each negative half cycle is inverted; the result is a varying and nonzero DC voltage whose maximum value will be half the AC peak to peak voltage, assuming a symmetrical waveform. Since the rectified average value and the root mean square (RMS) value of a waveform are only the same for a square wave, simple rectifier-type circuits can only be calibrated for sinusoidal waveform. Other wave shapes require a different calibration factor to relate RMS and average value. This type of circuit usually has fairly limited frequency range. Since practical rectifiers have non-zero voltage drop, accuracy and sensitivity are poor at low AC voltage values.

To measure resistance, switches arrange for a small battery within the instrument to pass a current through the device under test and the meter coil. Since the current available depends on the state of charge of the battery which changes over time, a multimeter usually has an adjustment for the ohm scale to zero it. In the usual circuits found in analog multimeters, the meter deflection is inversely proportional to the resistance, so full-scale will be 0 Ω, and higher resistance will correspond to smaller deflections. The ohms scale is compressed, so resolution is better at lower resistance values.

3.12 Charge Controller

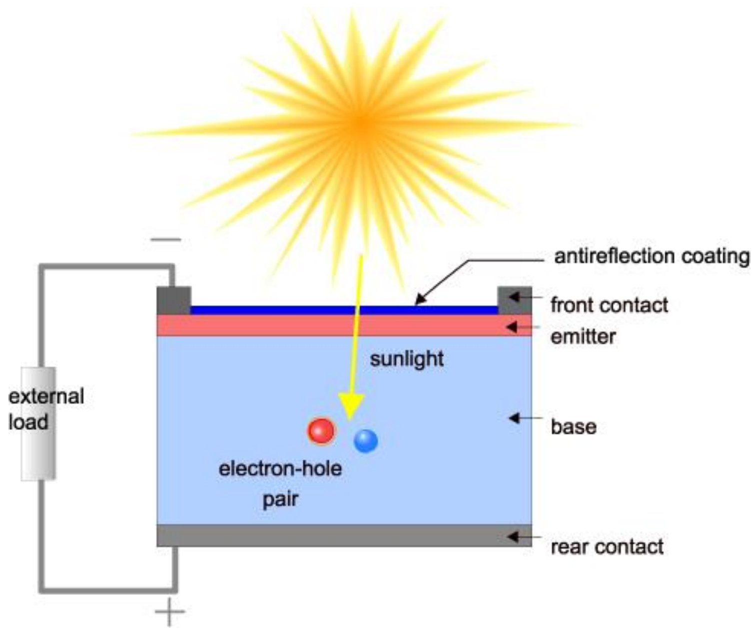


Figure 3.10: Solar Panel Schema Diagram

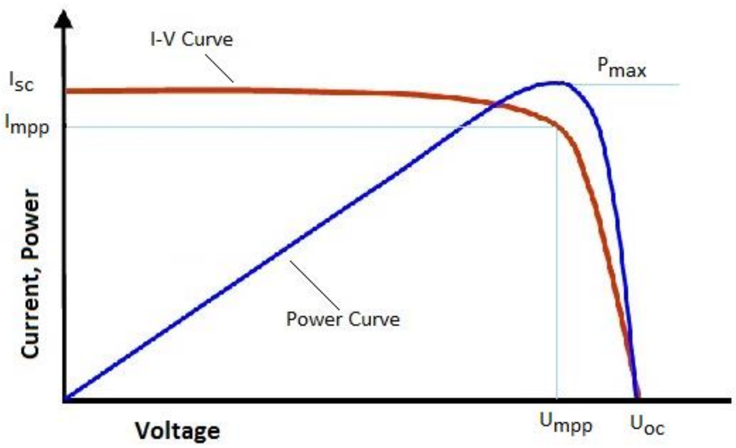


Figure 3.11: Solar Sell System Curve

Here is a solar charger circuit that is used to charge Lead Acid or Ni-Cd batteries using the solar energy power. The circuit harvests solar energy to charge a 6volt 4.5 Ah rechargeable battery for various applications. The charger has voltage and current regulation and over voltage cut-off facilities.

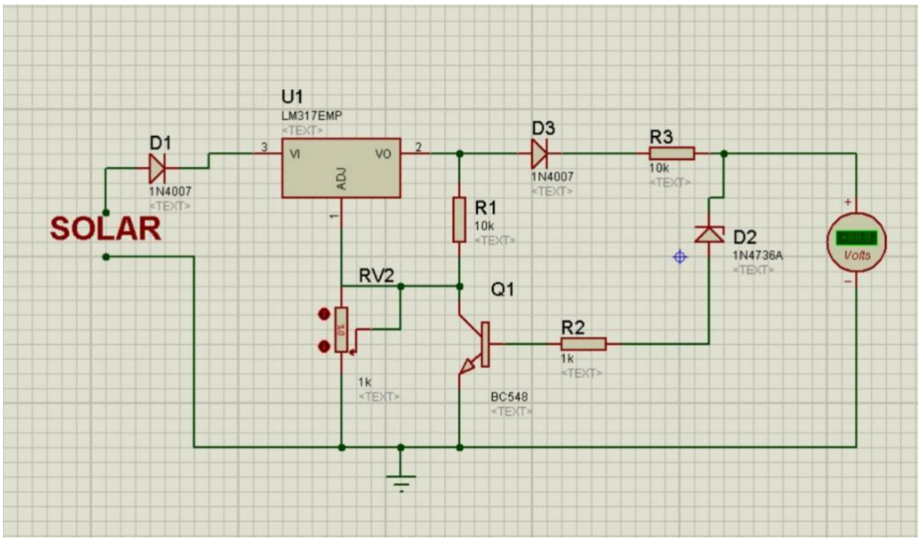


Figure 3.12: Solar Charger Controller Circuit

The circuit uses a 12volt solar panel and a variable voltage regulator IC LM 317. The solar panel consists of solar cells each rated at 1.2 volts. 12volt DC is available from the panel to charge the battery. Charging current passes through D1 to the voltage regulator IC LM 317. By adjusting its Adjust pin, output voltage and current can be regulated. VR is placed between the adjust pin and ground to provide an output voltage of 9 volts to the battery. Resistor R3 Restrict the charging current and diode D2 prevents discharge of current from the battery.

Transistor T1 and Zener diode ZD act as a cutoff switch when the battery is full. Normally T1 is off and battery gets charging current. When the terminal voltage of the battery rises above 6.8 volts, Zener conducts and provides base current to T1. It then turns on grounding the output of LM317 to stop charging.

3.13 Battery

Lithium batteries are primary batteries that have metallic lithium as an anode. These types of batteries are also referred to as lithium-metal batteries. They stand apart from other batteries in their high charge density and high cost per unit. Depending on the design and chemical compounds used, lithium cells can produce voltages from 1.5 V (comparable to a zinc–carbon or alkaline battery) to about 3.7 V.

Disposable primary lithium batteries must be distinguished from secondary lithium-ion or a lithium-polymer,[1] which are rechargeable batteries. Lithium is especially useful, because its ions can be arranged to move between the anode and the cathode, using an intercalated lithium compound as the cathode material but without using lithium metal as the anode material. Pure lithium will instantly react with water, or even moisture in the air; the lithium in lithium-ion batteries is in a less reactive compound.

Lithium batteries are widely used in portable consumer electronic devices. The term "lithium battery" refers to a family of different lithium-metal chemistry, comprising many types of cathodes and electrolytes but all with metallic lithium as the anode. The battery requires from 0.15 to 0.3 kg of lithium per kWh. As designed these primary systems use a charged cathode, that being an electro-active material with crystallographic vacancies that are filled gradually during discharge.

Figure 3.13: 3.7V Battery

Product specification

Table :1: Product Specification

Voltage	3.7 V
Product Type	Lithium-Ion
Battery Capacity	2200mAh
Weight	45 g
Model Number	ICR 18650

3.14 Working Principle

- The power generator electromagnetic suspension system is a system that converts vehicle bump generated linear motion & vibration, into electricity to be used in battery charging.

- General vehicle shock absorbers are used to simply absorb this energy without converting it to electricity. To achieve this, we here use the principles of electromagnetism in order to generate electricity from this motion.

- Here after produce this energy we store in a battery by charge controller circuit.

- 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.

3.15 Components List:

1. Metal Shaft.
2. Spring.
3. Inner Rod.
4. Battery
5. Charge Controller
6. Magnet.
7. Copper Coil.
8. Frame Base.
9. Screw & Joint.
10. Digital Multi Meter.

3.16 Complete Project Prototype Image

Figure 3.14: Project Prototype Image

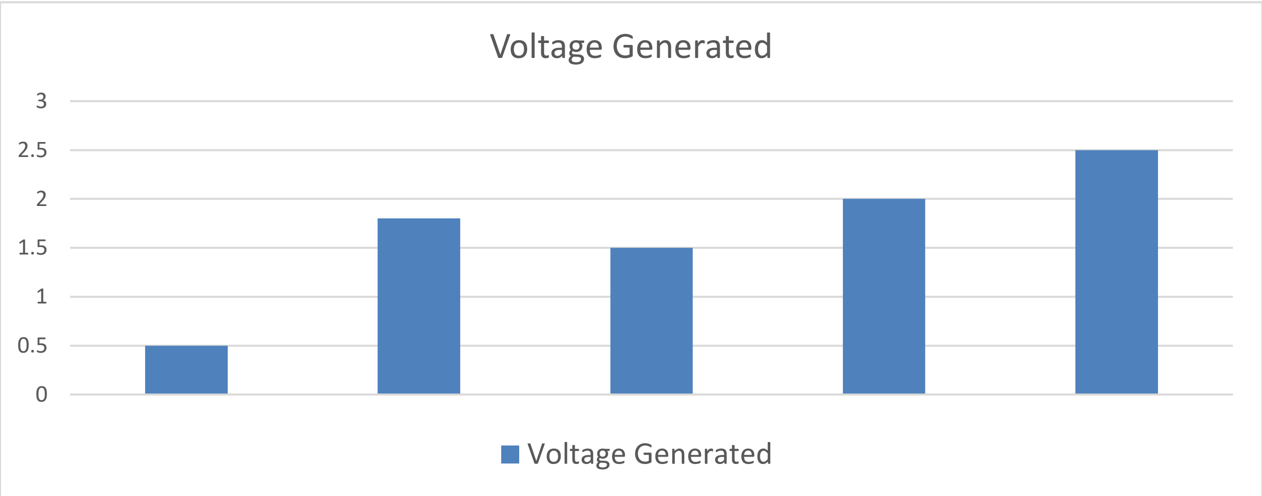
CHAPTER 4

RESULT AND DISCUSSION

4.1 Performance Test

With some modification of the system also pressing by hand we observe 0 to 2.5 volts with the help of multi meter.

Voltage Generated (V) =0- 2.5 volt



4.2 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involve improvement in system design and wiring, adding features for more efficiency.

4.3 Advantage

- Free Energy Generation
- Low Maintenance Part
- Energy Saving
- We can store energy in battery.
- Very effectively work for generate power generation.
- Reduce energy waste.
- No Oil consumption.
- Less skill technicians are sufficient to operate.
- Simple construction
- Ease of operation.

4.4 Application

The project has a major application in the

- It can be used for Industrial work.
- It can be used in Motorcycle others Vehicle.
- It can be used in factories for store power from this system.
- It can also use as speed breaker on a road with some modification to the system.
- It can be placed at densely populated area such as at entry and exit of shopping mall, railway station, airport, metro station etc.

4.5 Limitation

It is a demo project so we found some limitation. In future we will work for reduce this kind of limitation. These limitations are –

- In this system power generation limit is very poor. After future modification we will increase our power generation limit.
- In this system we press suspension system manually.
- Not applicable for all types of two wheelers.
- Not suitable for scooter.

CHAPTER 5
CONCLUSION

5.1 Conclusion:

The main objective of this project was to develop an object power generation on certain specifications. This was successfully implemented. We consider this project as a journey where we acquired knowledge and also gained some insights into the subject which we have shared in this report. Here use in various equipment for generate power. More features can be added to this system as follows: depending on the size, shape and weight of the objects.

5.2 Future Scope

The model can be improved by making some changes in the components. Some suggestions are given below-

- In future we will add automatic pressure in shock absorber.
- In future we will add a display to monitor the power generation.
- In future we will add a power storage system (Battery).
- After future modification we will increase our power generation limit.

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