ISSN No:-2456-2165

Comprehensive Study of Various Methods of Power Generation through Suspension System

S Logeshwaran (Assistant Prof.)
Automobile Department
SRM Institute of Science & Technology
Chennai, India

S Sudheer (*Final year student*)
Automobile Department
SRM Institute of Science & Technology
Chennai, India

Chiranjeev Tiwari (*Final year student*)
Automobile Department
SRM Institute of Science & Technology
Chennai, India

Ritesh Kumar Rai (*Final year student*)
Automobile Department
SRM Institute of Science & Technology
Chennai, India

Abstract:- Hydraulic shock absorbers consolidated vehicle suspensions decades back to viably diminish the increasing speed of the vehicle bodies and support great contact between tires and ground beneath irregularities. Albeit the energy proficiency has been the major concern in the automotive industry, analysts discerned the energy dissemination in conventional shock absorbers was worthy of being moderated within the mid-1900s. From that point, a few sorts of energy harvesting shock absorbers were conceived and prototyped. Unlike conventional shock absorbing system which smothers the vibration energy into heat energy, the regenerative shock absorber system converts the dissipated heat energy into electrical energy. This paper is a comprehensive consideration of the comparison of energy harvesting based vehicle suspensions.

Keywords:- *Energy, Vehicle Suspension, Shock Absorber, Rack and Pinion, Regenerative, Energy Harvesting.*

I. INTRODUCTION

For the past few generations, the prevailing ways of creating power caused a colossal sum of carbonic acid gasses and auxiliary aura contaminated miasma radiation to lead to the augmentation in the field of viable resources for curbing the carbonic acid gasses exudation.

The fossil powers are being expended at a quick rate. To the cost of fuel is sky soaring. Keeping in intellect the everyday needs of a human being, specifically or by implication they are related to the taking of fossil powers like petrol, diesel, etc.

There are numerous provenance to beget vitality either viably or non-viably. But the past generations have been relentlessly employing the non-viable resources to beget power. Veritably, the non-viable resources are on the edge of annihilation.

Bringing forth power through the non-viable provenances of energy is more exorbitant in the long run than viable vitality.

Henceforth, the evolving nations that hover specialized resources and money related confinement got to produce power by utilizing those sorts of innovation which can minimize their taken a toll in this division. Presently a day's recently created innovation attempt to progress the fet ched viability for producing control in this way they can be more compelling for a country.

Regenerative shock absorbers are being studied for a long time to recover the vibrational energy that is wasted in the form of heat. Based on the different energy conversion mechanism different types of regenerative shock absorbers have been made.

We propose the idea of converting dissipated heat energy into electrical energy from vehicle suspension to be used in a two wheelers effectively.Hence the electricity generated can be used to charge the battery.

II. LITERATURE REVIEW

The literature review is concerned with design of Shock Absorber, DC generator,selection of bearings with theoretical and experimental setup.

Zhongjie Li, Lei Zuo, JianKuang, and George Luhrs, proposed an unprecedented depiction of regenerative shock absorber which can work as a manageable damper as well as an energy generator. This setup is able to recuperate the dissipated vibrational energy simultaneously smothering the vibration induced by road bumps. The characteristic component includes Mechanical Motion Rectifier(MMR), which converts the bi-directional oscillatory vibration into unidirectional rotation of the generator.

Peng Li and Lei Zuo 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.

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

Shankar Singh and Nitin Vijay Satpute 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 .The following damper shows consistent damping performance and improved fail-safe characteristics.

Nitin V Satpute, Sarika N Satpute and Lalitkumar M Jugulkar proposed a hybrid electromagnetic damper constitutes of fluid damper and linear generator. Peculiar feature of the depiction is embodiment of fluid amplification link to enhance the relative velocity of the coil. Simulation results depict improvement in coil voltage by 9.85%, power enhances by 9.702%, set side by side the standard design. Embodiment of the fluid amplification assures the system dynamic properties are not undoubtedly affected.

Mustafa Demetgul and Ismail Guney proposed a hybrid energy-regenerative suspension system which integrates the combined hydraulic and electromagnetic mechanisms. The velocity values were chosen as low to analyse the systemic errors and leakages at low velocities. It was observed that for the measured velocities, as the speed increases, the amount of harvestable energy rate or efficiency increases.

R. B. Goldner and P. Zerigian proposed the study of determining the potency of efficiently transforming that energy into electrical energy by using superlative designed regenerative electromagnetic damper. Successively, the electrical energy can be used to recharge batteries or supercapacitors rather than being squandered.

Bin Yang, Chengkuo Lee, Wenfeng Xiang, Jin Xie, Johnny Han He, Rama Krishna Kotlanka, Siew Ping Low, Hanhua Feng 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.

Zutao Zhang , Xingtian Zhang, Weiwu Chen, Yagubov Rasim, Waleed Salman, Hongye Pan, Yanping Yuan, Chunbai Wang proposed a energy harvesting damper on dual over running clutches for an electric vehicle. A prototype damper was developed and subjected to sinusoidal displacement over a bench test was evaluated. Change in external load can provide variable damping coefficient.

Zhongjie Li, Lei Zuo, George Luhrs, Liangjun Lin, and Yi-xian Qinproposed a retrofit 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 damper can be used as a controllable damper.

Zhongjie Li, Zachary Brindak, and Lei Zuo stated the relationship between performance index and design parameter through modelling. Instead of a simple linear guide for rack, they implemented a roller and also added a preload between the guide and the rack. The backlash gear influences the dynamic properties of the system. The dynamic model created for the damper can also be used as semi/active control of the suspension.

III. ELEMENTS

A. Rack and Pinion Assembly

A rack and pinion may be a sort of linear gear over which the circular gear rotates and the gear ratio depends on the number of teeth of rack engaging with the circular gear (Pinion), when the rack moves longitudinally the pinion rotates. For the longitudinal motion of the rack, pinion has rotational motion and vice-versa.

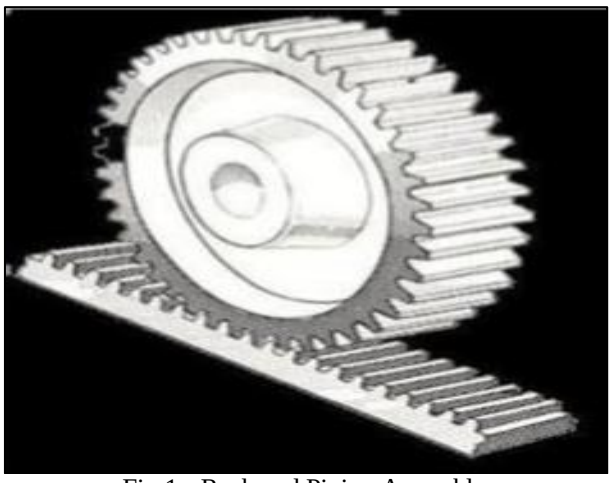


Fig 1:- Rack and Pinion Assembly

B. DC Generator

Whenever magnetic lines of force passing through a closed circuit changes, a current is induced in it. This phenomenon was discovered by Michael Faraday.

An electric generator that produces direct current is called a DC generator, which means that the current does not change it's direction with time.

The main components of a DC generator are, A horse shoe magnet with concave poles, a rectangular armature coil placed in between the two poles of the magnet. The axis of rotation of the coil is perpendicular to the direction of the magnetic field. A split ring commutator is attached to the

ends of the coil. Two graphite rods are kept in contact to the split ring commutator. The brushes are fixed and connected to the external circuit.

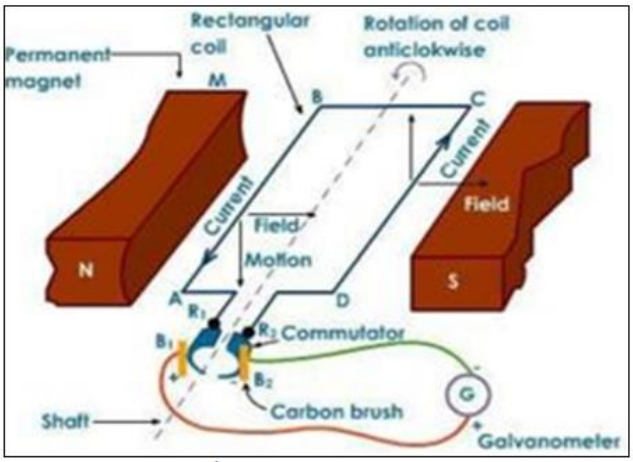


Fig 2:- DC Generator

C. Rectifier Circuit

A rectifier is an electrical device that converts alternating current (AC), which frequently changes it's order, to direct current (DC), which streams in only single order. This technique is acknowledged as rectification.

The preeminent interest of bridge rectifier is that it begets almost twice the yield voltage. But this course doesn't need midway knock transformer so it corresponds to cheap rectifier. The bridge rectifier course blueprint consists of distinct steps of devices like transformer, Diode Bridge, filters and regulators. Widely all these blocks consolidation is called as standardized DC power supply that powers distinct electronic appliances.

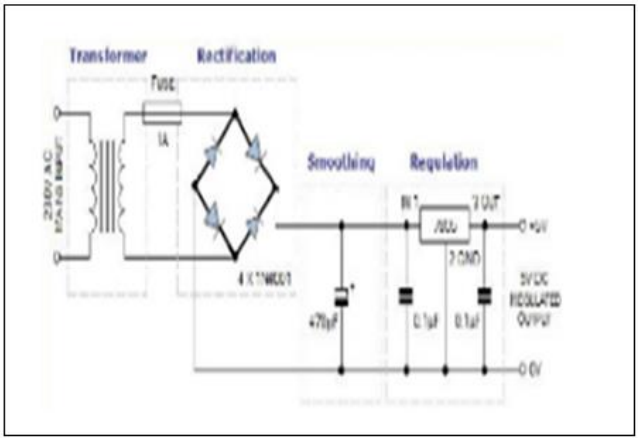


Fig 3:- Bridge Rectifier Circuit

D. Alternator

Alternator is nothing but a generator used in all the internal combustion engine vehicles and is a vital part of the battery charging system for a vehicle. When the engine is started, an alternator starts to rotate along with the crankshaft producing power. Hence, charging the battery and suppling electrical power to all the vehicle auxiliary systems.

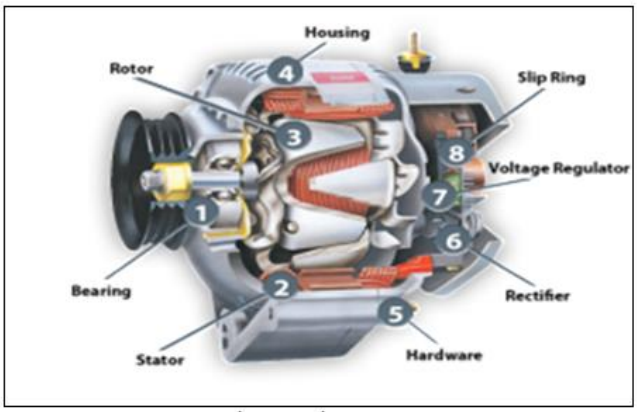
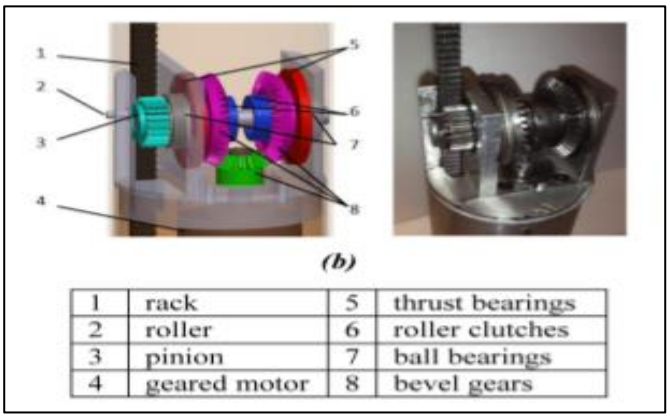


Fig 4:- Alternator

E. Mechanical Motion Rectifier

Mechanical Motion Rectifier is an upgraded and enhanced version of rotary electromagnetic harvestor, which converts the bidirectional linear motion of the suspension into bi directional rotation of the shaft through the rack and pinion and further into unidirectional motion by bevel gear and roller clutches.



(b)

1	rack	5	thrust bearings
2	roller	6	roller clutches
3	pinion	7	ball bearings
4	geared motor	8	bevel gears

Fig 5:- Mechanical Motion Rectifier

F. Hydraulic Motor

The fluid inside the shock absorber is sent to the hydraulic motor while compression and expansion of the shock absorber, through the valves at the top and bottom end of the shock absorber. Due to the payload the liquid will rotate the hydraulic motor which is connected to a DC generator, hence produces electric current.

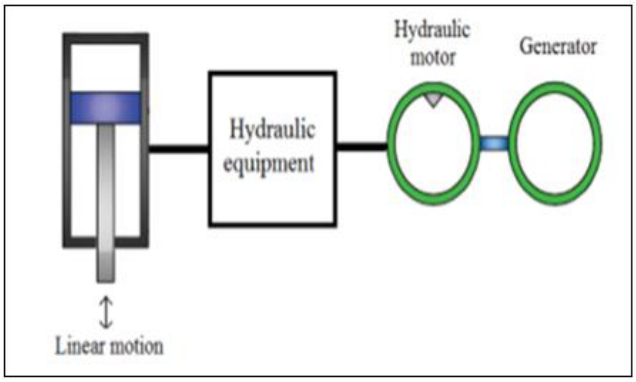


Fig 6:- Hydraulic Motor

G. Ball- Screw Mechanism

This mechanism is more or less similar to rack and pinion mechanism, the rotating motion of the screw is given as the vertical motion of the screw along the nut produced rotating motion. Due to the bobbing travel of the suspension, the transfigured rotating motion is two-directional, hence requires rectification. This type of shock absorbers is not at all suitable for performing at high frequencies.

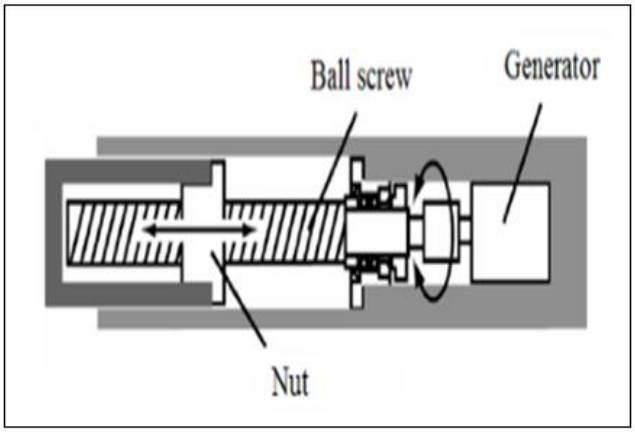


Fig 7:- Regenerative shock absorber using ball screw mechanism

H. Linear Generator

This type of energy harvesting damper constituents of a magnet and coil assembly. Magnets are placed in the center and coil is mounted on both sides of the damper. Any vibration produced due to the road irregularities creates vibration in the suspension system which in turn causes displacement between the magnet and coil assembly, causing change in magnetic flux, hence producing electrical energy.

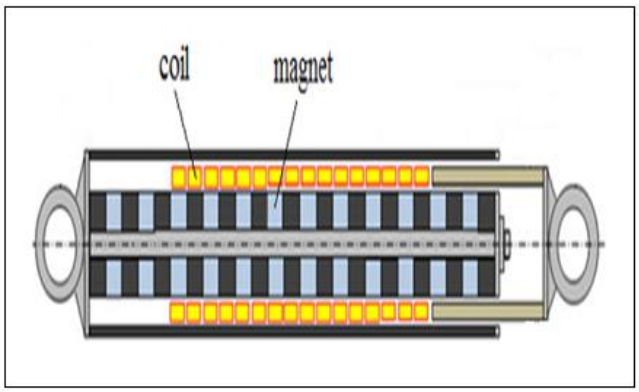


Fig 8:- Linear regenerative shock absorber

IV. CONCLUSION

This paper focuses on to provide a comprehensive review on automobile regenerative suspension systems including various designs and mechanisms. The analogous regenerative based damper configuration and its types were described briefly.

Regarding our review, it can be suggested that electromagnetic energy harvesting suspension system are so far the most advanced in the automobile industry. Accompanied with hydraulic amplification comprising of amplification cylinder and linear generator shows recovery of around 50.56W.

Supplementary analysis is afoot to revamp the efficiency of vitality recovered from a regenerative suspension system.

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