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Shock Absorbers Based on Magnetic Principles

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Abstract—*Aiming at a totally new concept in vehicle suspension systems, this paper leads to a viable alternative of the conventional shock absorbers which are made of steel coils and liquid filled pistons when put together provides required conditions of a suspension system. Magnetic properties of a material are utilized in this context especially permanent magnets because of their ability to maintain the magnetic behavior for a sufficiently long duration. In this system, we are considering the strongest permanent magnets to replace the conventional system which are rare earth magnets, such as neodymium magnets*

Keywords*: Permanent magnets. Vehicle dynamics, suspension geometry, magnetic field strength, ANSYS magnetism module, Solid Works modeling.*

1. INTRODUCTION

An automobile is an integral part of a human life as it carries a large mass of our population from one place to another. For an automobile to function properly, several assemblies have to function cordially and properly. Among them one is suspension. It consists of a link(s) which connects the wheel from the body and a shock absorber which provides enough traction on wheel and a comfortable drive. At present shock absorbers consists of springs (solid steel tubes) with a closely packed piston assembly (damper) set up in parallel to each other.

2. ISSUES IN CONVENTIONAL SHOCK ABSORBER

There are several problems in the conventional systems such as their heavy weights, high cost, low energy recovery options and fewer repairing possibilities.

Due to such issues following can be noticed easily in any vehicle.

- Longer stopping distances
- Swerving and nose dives
- Vibrations in seats
- Car sliding and veering
- Rocking and rattling
- Uneven tyre wear [1]

Technically these issues arise due to fatigue failure in coils or cavitation in the damper systems. Other reason may include improper load distribution and misalignment while installing the system. These issues motivated to provide an alternate to the conventional suspension type.

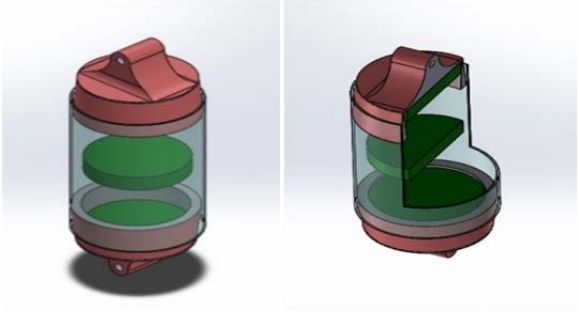
3. PROPOSED DESIGN

In this system, the conventional shock absorbers are intended to replace with an assembly of neodymium magnets arranged in serial inside a closely packed cylinder filled with coolants to prevent temperature rise. The arrangement is such that upon loading the magnets will come close to each other and produce a strong enough repulsive force which will resists the loading(in conventional ones, performed by springs) and keep the vehicle on its course along with cushioning effect along with damping capability and providing comfort to the passengers. Due to variety of neodymium magnets available in market based upon their magnetic strength and their working temperature range, it provides us a large range of shock absorbers to use for different types vehicles classified on their purpose. The casing of the assembly could be of any non-magnetic material due to the reason of very strong magnetic properties of magnets involved in action inside.

Design Requirements

- Adjustable length for variable ground clearance
- Capable to perform over a range of conditions
- Critically Damped
- Energy Regeneration
- Durability
- Failure proof materials
- Zero Maintenance

Following shown is a proposed design of the shock absorber assembly. The green parts are Neodymium Magnets which are 3 in number placed co-axially facing identical poles with each other at similar distance apart.



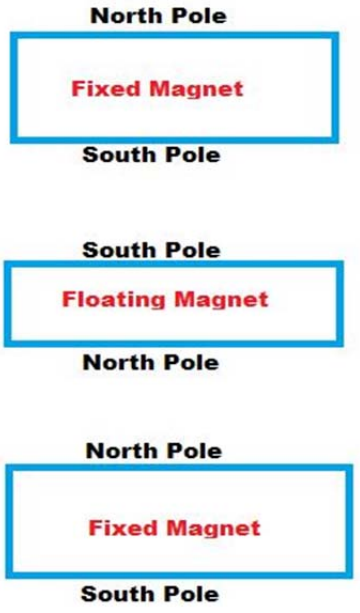
Proposed Design and cross-sectional view

One end of the assembly will be fixed and other end will be allowed to reciprocate in order to perform the task of shock absorption coupled with damping. The fixed end will contain one N-Magnet which will be fixed in the magnetic holder to maintain its position with respect to other magnets. The casing is connected from the fixed end to the movable end, it contains the floating magnet which is allowed to move within the casing from fixed end to movable end, this magnet will balance the load applied from outside and will provide a quick damping effect. There are three cylindrical magnets arranged in the following sequence.

- One at movable end
- One in between movable and fixed end that is floating
- One at fixed end.

As we are using magnets which can move up and down during shocks can produce flux change around the coil which can be wrapped along casing of shock absorber. This ultimately leads to production of much needed electricity for operation of different circuits in an automobile.

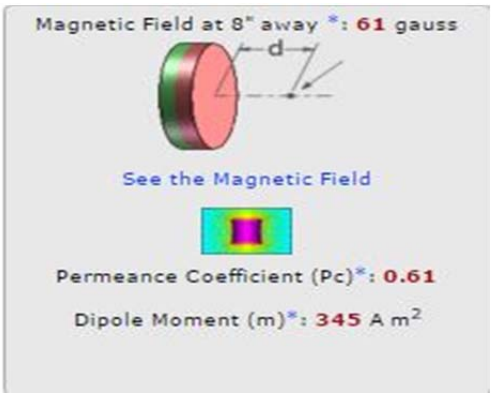
The arrangement shown ahead is the simplest to achieve the task required. At the fixed end of shock absorber (which is connected to frame/body of the vehicle) a magnet is fixated with its pole as shown in diagram ahead. At the other end of shock absorber another similar magnet is fixed with reversed pole arrangement. In between these fixed magnets, floating magnet will operate due to variable magnetic field and bumps and droops experienced by the vehicle on the road course. The regular movement of floating movement will result in increase in temperature of the system, for which a coolant is required to maintain the system at optimum temperature range so that magnets could operate accurately for longer duration.



Magnetic poles arrangement in shock absorber

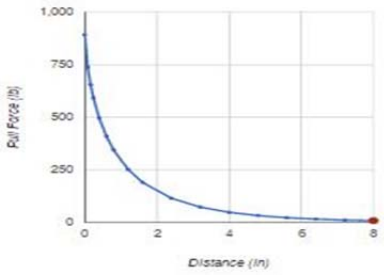
4. SIMULATION

A sample run of the magnetic field of the aforementioned arrangement was done with help of available resources online and the results are summarized as follows.

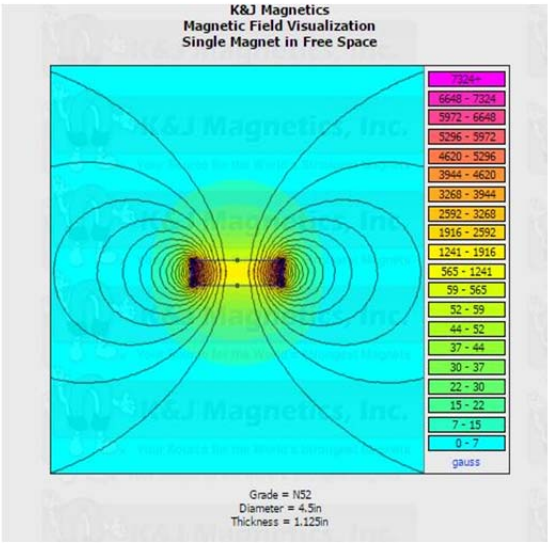


The dimensions of magnets as input data were:

- Thickness - 1.125 inch
- Diameter – 4.5 inch
- Magnet – N52 (Neodymium Magnet)



Grade = N52
Diameter = 4.5"
Thickness = 1.125"
Distance = 8"
7.51 lb



[2]

5. CONCLUSION

In this work, an alternate and feasible model for a shock absorber is proposed which will minimize the failures in the current system of spring and damper along with features as low weight, better performance and moreover at a lower cost. The simulations shown here are required to study as a sample only because of limitations of the resources available as of now.

6. FUTURE PROSPECTS

A lot of improvements in performance are possible such as:

- Energy Regeneration to operate AC/lamps/etc
- Study of larger diameters to increase repulsion
- Study of coolant and effects on magnetic field.
- Conductor placement in casing to improve performance.

REFERENCES

[1] http://www.motoringabout.com/when-to-replace-shock-absorbers/

[2] https://www.kjmagnetics.com/calculator.repel.asp