MAGNETIC SHOCK ABSORBERS

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1. Abstract
The idea for a magnetic shock absorber (for automobiles and two-wheelers), 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 poles of two magnets of the same properties and strength repulse each other and they keep a constant distance between each other because of their magnetic fields. This made her think that if the shock absorbers are made of magnets with similar poles facing each other, it may give better performance and no maintenance would be required for the same.

INTRODUCTION

The unit comprises of two circular magnets and a rod (straight cylindrical rod which can be used as axle). One magnet is attached at the bottom of the rod and is the base magnet. The other magnet is free, with a float and has the similar pole placed towards the base magnet. The similarity of poles creates repulsion and a certain distance is maintained. As per load condition, the floating magnet moves and closes the gap until the magnetic repulsion is strong enough to create the damping action. In this manner a shock absorber without springs working on the basic law of magnets - opposite poles attract and similar poles repel- is prepared.

2. SHOCK ABSORBERS

A shock absorber in common parlance (or damper in technical use) is a mechanical device designed to smooth out or damp sudden shock impulse and dissipate kinetic energy. It is analogous to a resistor in an electric rlc circuit.

Shock absorbers must absorb or dissipate energy. One design consideration, when designing or choosing a shock absorber is where that energy will go. In most dashpots, energy is converted to heat inside the viscous fluid, in hydraulic cylinders, the
hydraulic fluid will heat up. In air cylinders, the hot air is usually exhausted to the atmosphere. In other types of dashpots, such as electromagnetic ones, the dissipated energy can be stored and used later.

2.1 USES OF SHOCK ABSORBERS

a) Vehicles suspension

In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality. Without shock absorbers, the vehicle would have a bouncing ride, as energy is stored in the spring and then released to the vehicle, possibly exceeding the allowed range of suspension movement. Control of excessive suspension movement without shock absorption requires stiffer (higher rate) springs, which would in turn give a harsh ride. Shock absorbers allow the use of soft (lower rate) springs while controlling the rate of suspension movement in response to bumps. They also, along with hysteresis in the tire itself, damp the motion of the unstrung weight up and down on the springiness of the tire. Since the tire is not as soft as the springs, effective wheel bounce damping may require stiffer shocks than would be ideal for the vehicle motion alone.

A spring-based shock absorber commonly use coil springs or leaf springs, though torsion bars can be used in tensional 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 springs or torsion bars as well as hydraulic shock absorbers. In this combination, "shock absorber" is reserved specifically for the hydraulic piston that absorbs and dissipates vibration.

b) Working of shock absorbers

Shock absorbers work in two cycles -- the compression cycle and the extension cycle. The compression cycle occurs as the piston moves downward, compressing the hydraulic fluid in the chamber below the piston. The extension cycle occurs as the piston moves toward the top of the pressure tube, compressing the fluid in the chamber above the piston. A typical car or light truck will have more resistance during its extension cycle than its compression cycle. With that in mind, the compression cycle controls the motion of the vehicle's unstrung weight, while extension controls the heavier, sprung weight.
c) Compression cycle
During the compression stroke or downward movement, some fluid flows through the piston from piston and in the compression valve. At the piston, oil flows through the oil ports, and at slow piston speeds, the first stage bleeds come into play and restrict the amount of oil flow. This allows a controlled flow of fluid from chamber b to chamber a. At faster piston speeds, the increase in fluid pressure below the piston in chamber b causes the control of fluid flow more precise.

d) Extension cycle
As the piston and rod move upward toward the top of the pressure tube, the volume of chamber a is reduced and thus is at a higher pressure than chamber b. Because of this higher pressure, fluid flows down through the piston’s 3-stage extension valve into chamber b. However, the piston rod volume has been withdrawn from chamber b greatly increasing its volume. thus the volume of fluid from chamber a is insufficient to fill chamber b. The pressure in the reserve tube is now greater than that in chamber b, forcing the compression intake valve to unseat. Fluid then flows from the reserve tube into chamber b, keeping the pressure tube full. Extension control is a force present as a result of the higher pressure in chamber a, acting on the topside of the piston area.

3.0 The magnetic shock absorber
Shock absorbers are a key component of all automobiles. They control the vehicle’s suspension movement to provide a stable, comfortable ride. Since they were installed on the first automobiles, the principle of shock absorber operation has remained essentially the same. Now a new type of shock absorber is entering the market, and it may change the way suspensions are controlled. They are called the magnetic shock absorbers or the new magnified shock system.

Magnetic shock absorber is a continuously variable shock absorber that uses simple magnetic principles but very high technology to control suspensions. Conventional shock absorbers (or struts on many cars) use oil passing through orifices to dampen suspension movement. When a tire hits a bump, the suspension moves up, moving the body of the shock absorber up too. a rod, connected to the top of the shock and mounted to the body or frame, passes through a seal in the top of the shock and has a piston mounted on the bottom end. This piston has small ports in it that allow oil contained in the shock body to flow from one side of the piston to the other. Different size ports allow different flow rates, so larger ports allow the suspension to move easier and smaller ports slow the movement.

Conventional shock absorbers use check valves on the ports so that fluid can pass easier one way than the other. Typically, the wheel is allowed to move up quickly, but let back down slower. This prevents the
suspension from bouncing; the effect you get when the shocks are badly worn.

Gas-filled shocks use pressure inside the shock to reduce oil foaming as it passes through the ports. Suspension control becomes very erratic with foamy oil inside the shock. Vehicles with selectable shock dampening vary the size of ports by turning a shaft inside the piston rod that changes port size to change vehicle handling. Magnetic shock absorber makes mechanically varied systems obsolete.

The heart of a magnetic shock absorber or magnified is the magneto-rheological (mr) fluid. it is a suspension of magnetically soft particles such as iron microspheres in a synthetic hydrocarbon base fluid. place a magnet near the fluid and the particles form a fibrous structure, increasing its shear factor. in simple terms, the fluid gets thicker so it doesn’t flow through the shock’s piston ports as easy.

by using an magnet placed in the shock piston, the mass fluid only changes viscosity where it passes through the ports. Wires run down the hollow piston rod so a computer module can vary the strength of the magnet and the dampening of the shock continuously. the system is five times faster than mechanical ride control systems.

In fact, the system is so quick; it performs 1000 calculations per second. This is equal to one calculation for every inch of vehicle travel at 60 miles per hour. Electro-magnetic shock absorbers can react to every little bump in the road.

Several sensors provide input to the magnified computer. Wheel to body sensors are used at each wheel to determine wheel travel and vertical acceleration. Vehicle speed and outside temperature come via data communication from other vehicle computers. The temperature data is used so the computer can compensate for fluid viscosity variations due to temperature. Magnified also improves vehicle stability control systems and uses a steering wheel angle sensor, yaw rate sensor and lateral acceleration sensor for accurate vehicle control.

for the auto engineers, magnified allows quicker calibration and suspension tuning for new vehicles. for drivers, magnified offers a flatter, smoother ride, enhanced lateral and longitudinal control of body movement, and better road isolation from the passenger compartment. While magnetite has limited availability now, it predicts we will see this feature on a wide range of automobiles in the near future.

![Fig:3 Structure of magnetic shock absorber](image)
3.1 Magneto-rheological fluid

Rheology is a science that studies the deformation and flow of materials. Rheological fluids have flow characteristics that can be changed in a controllable way using electrical current or a magnetic field. Depending on the base fluid and the strength of the electrical current or magnet, the fluid’s viscosity can be varied from thinner-than-water to almost-solid and any stage in between. The fluid’s response is instantaneous, completely reversible and extremely controllable, but there are some limits.

3.2 Shock absorber valves

It wasn’t hard to develop a synthetic oil-mr fluid with viscosity and lubrication qualities similar to normal hydraulic shock absorber oil. The challenge was to develop seals, o-rings and other components that can withstand the fluid’s “particle contamination,” which is part of the reason it’s taken so long for mr fluid to escape the laboratory. According to David Caldwell, communications manager for performance cars at gm, these shocks have been in development for 20 years. He said they were first used on open-wheeled racecars, where cost and durability are not quite as critical as in production cars. Working with lord corp., which manufactures the mr fluid, Delphi has finally developed mr shock absorbers that are suitable for real-world applications.
4.0 CONTROL SYSTEM

Because adjustable damping has been around for a while, all of the other bits and pieces needed for the magnified system are already in place. The control module uses suspension height data supplied by position sensors at each corner. With throttle position sensor (tps), transmission and wheel speed data supplied by the power train control module (pcm), the suspension controller can predict lift and dive at each end of the car and operate the shocks’ “valves” to counteract it. With data from a steering wheel position sensor, a two-plane acceleration sensor and a yaw rate sensor, the shocks can be operated as needed to control body roll during any maneuver. The system also checks body movement during anti-lock brake system (abs) operation using vehicle speed, wheel speed and other data supplied by the abs control unit.

The magnified controller itself is a stand-alone unit equipped with two parallel processors: one for input signals and one for output. It operates the shocks on 5 volts dc that is pulse-width modulated to adjust current to the magnets. Current draw can spike momentarily at about 5 amps per shock, but normal current draw is about half that much, and there is always some current flowing whenever the key is on. Like earlier versions, this is a semi-active suspension system. in addition to its main function of keeping the wheels in contact with the road, it can check body motions and, within certain limits, adjust weight bias at each corner by preventing suspension compression. but it is a reactive system, not proactive, and it cannot extend the suspension to make the car lean into a turn. Still, it provides a significant amount of increased control with base settings that are tuned for a more comfortable ride.

5.0 Regenerative Electromagnetic Shock Absorber

A regenerative electromagnetic shock absorber comprising: a linear electromagnetic generator comprised of a central magnet array assembly comprising a central magnet array comprised of a plurality of axially-aligned, stacked cylindrical magnets having like magnetic poles facing one another, a plurality of high magnetic permeability, high saturation magnetization, central cylindrical spacers positioned at each end of said stacked central magnet array and between adjacent stacked central magnets, and a magnet array support for mounting said magnets and said spacers; an inner coil array comprising a plurality of concentric cylindrical coil windings positioned adjacent to said central spacers and said magnetic poles of said central magnets, said inner coil windings surrounding an outside perimeter of said central spacers, said inner coil array mounted on a movable coil support, said movable coil support providing for reciprocating linear motion of said coil array relative to said magnet array; and an outer magnet array assembly comprising an outer magnet array comprised of a plurality of axially-aligned, stacked concentric steroidal magnets having like magnetic poles facing each other, said outer magnet array surrounding said inner coil array, said stacked outer concentric magnets being aligned and positioned essentially coplanar with said stacked central cylindrical magnets with the magnetic poles of said outer magnets aligned with and facing opposing magnetic poles of said central cylindrical magnets, and a plurality of high permeability, high saturation magnetization, outer concentric steroidal spacers positioned at each end of said stacked outer...
magnet array and between adjacent stacked outer magnets, said outer magnet array assembly attached to said magnet array support; wherein a predetermined location, configuration and orientation of said central magnet magnetic poles, said central spacers, said inner coil windings, said outer magnet magnetic poles and said outer spacers provide for superposition of a radial component of a magnetic flux density from a plurality of central and outer magnets to produce a maximum average radial magnetic flux density in the inner coil windings; and a voltage conditioning circuit electrically connected to said coil windings, said voltage conditioning circuit providing an output voltage and output current to an electrical load.

Fig:6 Regeneration of magnetic field
An electromagnetic linear generator and regenerative electromagnetic shock absorber is disclosed which converts variable frequency, repetitive intermittent linear displacement motion to useful electrical power. The innovative device provides for superposition of radial components of the magnetic flux density from a plurality of adjacent magnets to produce a maximum average radial magnetic flux density within a coil winding array. Due to the vector superposition of the magnetic fields and magnetic flux from a plurality of magnets, a nearly four-fold increase in magnetic flux density is achieved over conventional electromagnetic generator designs with a potential sixteen-fold increase in power generating capacity. As a regenerative shock absorber, the disclosed device is capable of converting parasitic displacement motion and vibrations encountered under normal urban driving conditions to a useful electrical energy for powering vehicles and accessories or charging batteries in electric and fossil fuel powered vehicles. The disclosed device is capable of high power generation capacity and energy conversion efficiency with minimal weight penalty for improved fuel efficiency.

CONCLUSION:
A conventional automotive shock absorber dampens suspension movement to produce a controlled action that keeps the tire firmly on the road. This is done by converting the kinetic energy into heat energy, which is then absorbed by the shock’s oil. The power-generating shock absorber (pgsa) converts this kinetic energy into electricity instead of heat through the use of a linear motion electromagnetic system (lmes). The lmes uses a dense permanent magnet stack embedded in the main piston, a switchable series of stator coil windings, a rectifier, and an electronic control system to manage the varying electrical output and damping load.
REFERENCES: