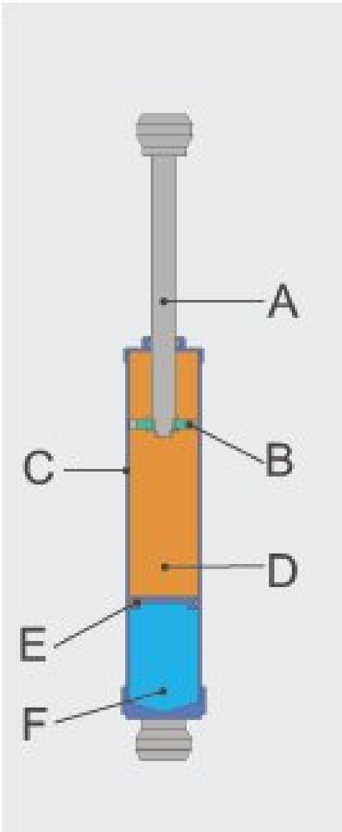
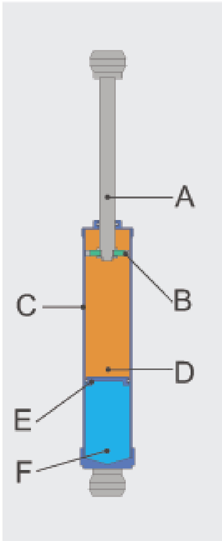
Shock absorber

A **shock absorber** (see alternate names below) is a mechanical device (one kind of dashpot) designed to smooth out or damp shock impulse, and dissipate kinetic energy.



Shock absorber with internal reservoir.
The components are:
A - rod,
B - the piston with seals,
C - the cylinder,
D - oil reservoir,
E - floating piston,
F - air chamber.



Nomenclature

- The device's name in common parlance (among the general public and auto mechanics) is **shock absorber** or simply **shock**.
- Technical names include **damper** and **dashpot**. (They are a subset of dashpots and thus are sometimes called "dashpots", just as cars are a subset of vehicles and are sometimes called "vehicles".)
- For a while during the 20th century in the U.S., the **Houdaille** brand (pronounced WHO-dye) was in some places so well known that the name "Houdaille" served as a genericized trademark for the category of product.[1] This is no longer the case; the brand is gone and so is the genericized usage.

Description

Pneumatic and hydraulic shock absorbers commonly take the form of a cylinder with a sliding piston inside. The cylinder is filled with a fluid (such as hydraulic fluid) or air. This fluid-filled piston/cylinder combination is a dashpot.

Explanation

The shock absorber's duty is to 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, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of dashpots, such as electromagnetic types, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion vehicles on uneven roads.

Applications

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. A transverse mounted shock absorber, called a yaw damper, helps keep railcars from swaying excessively from side to side and are important in passenger railroads, commuter rail and rapid transit systems because they prevent railcars from damaging station platforms. The success of passive damping technologies in suppressing vibration amplitudes could be ascertained with the fact that it has a market size of around $ 4.5 billion.

Rear shock absorber and spring of a BMW R75/5 motorcycle

Vehicle suspension

In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. 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 unsprung 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.

Spring-based shock absorbers commonly use coil springs or leaf springs, though torsion bars can be 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 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

Structures

Applied to a structure such as a building or bridge it may be part of a seismic retrofit or as part of new, earthquake resistant construction. In this application it allows yet restrains motion and absorbs resonant energy, which can cause excessive motion and eventual structural failure.

Electrical Generation

Modern hybrid cars may eventually be able to generate useful energy from the displacement of the fluid in a shock absorber[2] .

Types of shock absorbers

There are several commonly-used approaches to shock absorption:

- Hysteresis of structural material, for example the compression of rubber disks, stretching of rubber bands and cords, bending of steel springs, or twisting of torsion bars. Hysteresis is the tendency for otherwise elastic materials to rebound with less force than was required to deform them. Simple vehicles with no separate shock absorbers are damped, to some extent, by the hysteresis of their springs and frames.
- Dry friction as used in wheel brakes, by using disks (classically made of leather) at the pivot of a lever, with friction forced by springs. Used in early automobiles such as the Ford Model T, up through some British cars of the 1940s. Although now considered obsolete, an advantage of this system is its mechanical simplicity; the degree of damping can be easily adjusted by tightening or loosening the screw clamping the disks, and it can be easily rebuilt with simple hand tools. A disadvantage is that the damping force tends not to increase with the speed of the vertical motion.
- Solid state, tapered chain shock absorbers, using one or more tapered, axial alignment(s) of granular spheres, typically made of metals such as nitinol, in a casing. [3],[4]
- Fluid friction, for example the flow of fluid through a narrow orifice (hydraulics), constitute the vast majority of automotive shock absorbers. An advantage of this type is that using special internal valving the absorber may be made relatively soft to compression (allowing a soft response to a bump) and relatively stiff to extension, controlling "rebound", which is the vehicle response to energy stored in the springs; similarly, a series of valves controlled by springs can change the degree of stiffness according to the velocity of the impact or rebound. Specialized shock absorbers for racing purposes may allow the front end of a dragster to rise with minimal resistance under acceleration, then strongly resist letting it settle, thereby maintaining a desirable rearward weight distribution for enhanced traction. Some shock absorbers allow tuning of the ride via control of the valve by a manual adjustment provided at the shock absorber. In more expensive vehicles the valves may be remotely adjustable, offering the driver control of the ride at will while the vehicle is operated. The ultimate control is provided by dynamic valve control via computer in response to sensors, giving both a smooth ride and a firm suspension when needed. Many shock absorbers contain compressed nitrogen, to reduce the tendency for the oil to foam under heavy use. Foaming temporarily reduces the damping ability of the unit. In very heavy duty units used for racing and/or off-road use, there may even be a secondary cylinder connected to the shock absorber to act as a reservoir for the oil and pressurized gas. Another variation is the Magneto rheological damper which changes its fluid characteristics through an electromagnet.
- Compression of a gas, for example pneumatic shock absorbers, which can act like springs as the air pressure is building to resist the force on it. Once the air pressure reaches the necessary maximum, air dashpots will act like hydraulic dashpots. In aircraft landing gear air dashpots may be combined with hydraulic damping to reduce bounce. Such struts are called *oleo struts* (combining oil and air) [5].
- Magnetic effects. Eddy current dampers are dashpots that are constructed out of a large magnet inside of a non-magnetic, electrically conductive tube.
- Inertial resistance to acceleration, for example prior to 1966 [6] the Citroën 2CV had shock absorbers that damp wheel bounce with no external moving parts. These consisted of a spring-mounted 3.5 kg (7.75 lb) iron weight inside a vertical cylinder [7] and are similar to, yet much smaller than versions of the tuned mass dampers used on tall buildings
- Composite hydropneumatic devices which combine in a single device spring action, shock absorption, and often also ride-height control, as in some models of the Citroën automobile.
- Conventional shock absorbers combined with composite pneumatic springs which allow ride height adjustment or even ride height control, seen in some large trucks and luxury sedans such as certain Lincoln and most Land Rover automobiles. Ride height control is especially desirable in highway vehicles intended for occasional rough

road use, as a means of improving handling and reducing aerodynamic drag by lowering the vehicle when operating on improved high speed roads.

- The effect of a shock absorber at high (sound) frequencies is usually limited by using a compressible gas as the working fluid and/or mounting it with rubber bushings.

Developments

Regenerative shock absorbers

Levant Powerhas identified an electricity source in the suspension and it is used in its GenShock system. [8]

See also

- Strut
- Strut bar
- Base isolation

Bibliography

- Holland, Max (1989), *When the Machine Stopped: A Cautionary Tale from Industrial America*, Boston: Harvard Business School Press, ISBN 978-0-87584-208-0

External links

- *This Motor-Truck Hasn't Any Springs*, Popular Science monthly, February 1919, page 59, Scanned by Google Books: http://books.google.com/books?id=7igDAAAAMBAJ&pg=PA59
- MIT Undergrads Create Shock Absorber That Generates Energy [9].
- *M3D: mechanics and mechanisms of material damping* By Vikram K. Kinra, Alan Wolfenden

References

[1] Holland 1989, pp. 53-54.
[2] http://news.nationalgeographic.com/news/2009/02/090219-shock-absorber-energy-cars.html
[3] http://physicsweb.org/articles/news/5/10/15/1
[4] http://unisci.com/stories/20014/1022011.htm
[5] http://www.hangar9aeroworks.com/Aeroncastrut/Aeroncastrut.html
[6] http://www.citroenet.org.uk/passenger-cars/michelin/2cv/2cv-01.html
[7] http://www.canadiandriver.com/articles/bv/2cv.htm
[8] http://www.levantpower.com/technology.html
[9] http://www.renewableenergyworld.com/rea/news/article/2009/02/mit-shock-absorber-increases-fuel-economy?cmpid=WNL-Wednesday-February25-2009#imageGallery