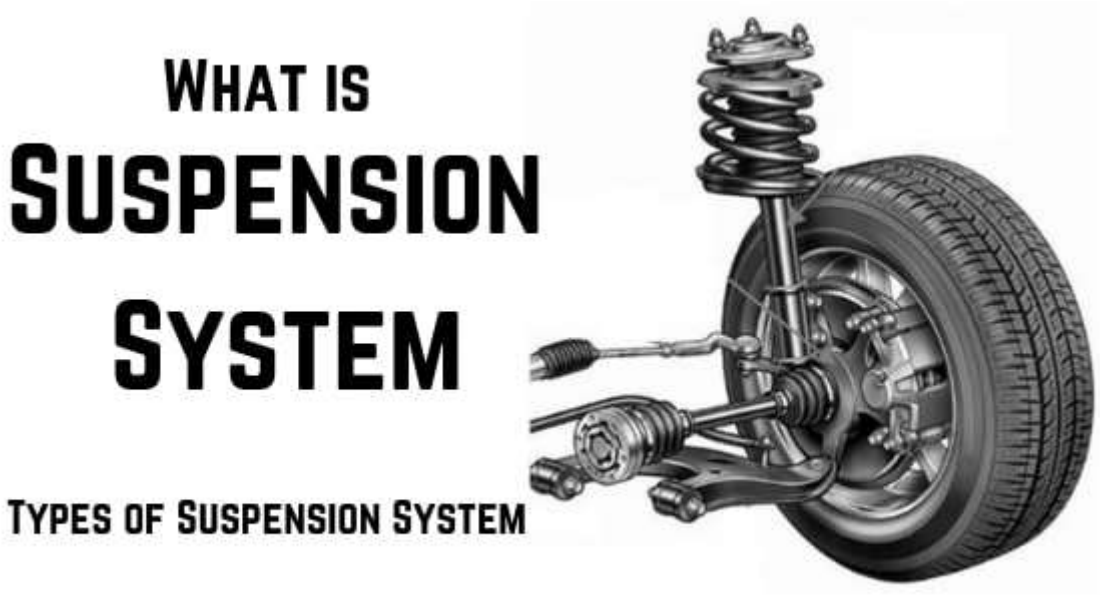
Types of Suspension System used in Automobile



Definition:

Suspension is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems must support both road holding/handling and ride quality, which are at odds with each other. The tuning of suspensions involves finding the right compromise. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the road or ground forces acting on the vehicle do so through the contact patches of the tires. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear. The design of front and rear suspension of a car may be different.

Part of car front suspension and steering mechanism: tie rod, steering arm, king pin axis (using ball joints).

History

Early history

An early form of suspension on ox-drawn carts had the platform swing on iron chains attached to the wheeled frame of the carriage. This system remained the basis for most suspension systems until the turn of the 19th century, although the iron chains were replaced with the use of leather straps called thorough braces by the 17th century. No modern automobiles have used the thorough brace suspension system.

By approximately 1750, leaf springs began appearing on certain types of carriage, such as the Landau. By the middle of the 19th century, elliptical springs would also begin to be used on carriages.

Modern suspension:

Automobiles were initially developed as self-propelled versions of horse-drawn vehicles. However, horse-drawn vehicles had been designed for relatively slow speeds, and their suspension was not well suited to the higher speeds permitted by the internal combustion engine.

The first workable spring-suspension required advanced metallurgical knowledge and skill, and only became possible with the advent of industrialisation. Obadiah Elliott registered the first patent for a spring-suspension vehicle; each wheel had two durable steel leaf springs on each side and the body of the carriage was fixed directly to the springs which were attached to the axles. Within a decade, most British horse carriages were equipped with springs; wooden springs in the case of light one-horse vehicles to avoid taxation, and steel springs in larger vehicles. These were often made of low-carbon steel and usually took the form of multiple layer leaf springs.

Leaf springs have been around since the early Egyptians. Ancient military engineers used leaf springs in the form of bows to power their siege engines, with little success at first. The use of leaf springs in catapults was later refined and made to work years later. Springs were not only made of metal; a sturdy tree branch could be used as a spring, such as with a

bow. Horse-drawn carriages and the Ford Model T used this system, and it is still used today in larger vehicles, mainly mounted in the rear suspension.

Leaf springs were the first modern suspension system and, along with advances in the construction of roads, heralded the single greatest improvement in road transport until the advent of the automobile. The British steel springs were not well-suited for use on America's rough roads of the time, so the Abbot-Downing Company of Concord, New Hampshire re-introduced leather strap suspension, which gave a swinging motion instead of the jolting up and down of a spring suspension.

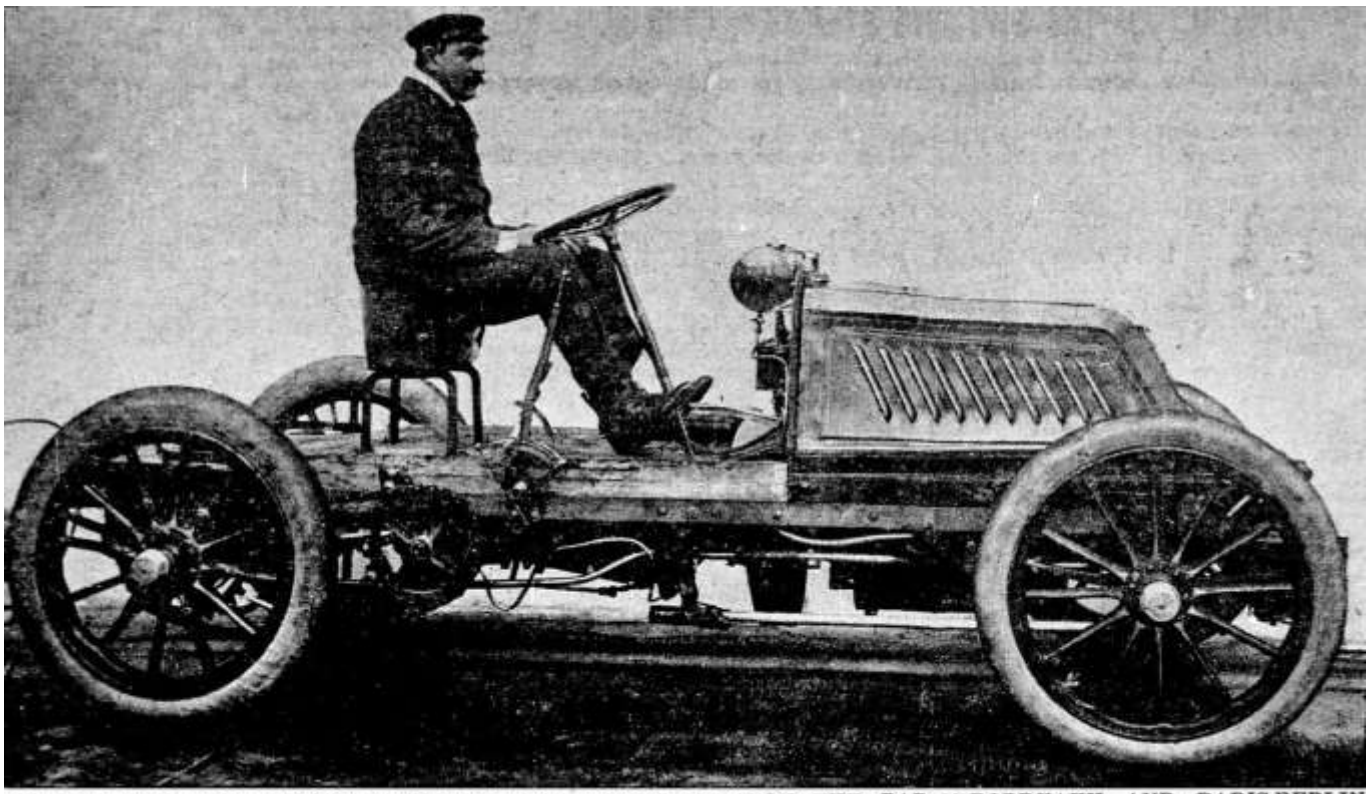
In 1901 Mors of Paris first fitted an automobile with shock absorbers. With the advantage of a damped suspension system on his 'Mors Machine', Henri Fournier won the prestigious Paris-to-Berlin race on 20 June 1901. Fournier's superior time was 11 hrs 46 min 10 sec, while the best competitor was Léonce Girardot in a Panhard with a time of 12 hrs 15 min 40 sec.

Coil springs first appeared on a production vehicle in 1906 in the Brush Runabout made by the Brush Motor Company. Today, coil springs are used in most cars.

In 1920, Leyland Motors used torsion bars in a suspension system.

In 1922, independent front suspension was pioneered on the Lancia Lambda and became more common in mass market cars from 1932. Today, most cars have independent suspension on all four wheels.

In 2002, a new passive suspension component was invented by Malcolm C. Smith, the inerter. This has the ability to increase the effective inertia of a wheel suspension using a geared flywheel, but without adding significant mass. It was initially employed in Formula One in secrecy but has since spread to other motorsport.



FOURNIER ON THE "MORS" MACHINE WITH WHICH HE WON THE PARIS-BORDEAUX AND PARIS-BERLIN RACES AND BEAT THE VANDERBILT RECORD FOR ONE KILOMETRE.

Types

Suspension systems can be broadly classified into two subgroups: dependent and independent. These terms refer to the ability of opposite wheels to move independently of each other.

A dependent suspension normally has a beam (a simple 'cart' axle) or (driven) live axle that holds wheels parallel to each other and perpendicular to the axle. When the camber of one wheel changes, the camber of the opposite wheel changes in the same way (by convention on one side this is a positive change in camber and on the other side this a negative change). De Dion suspensions are also in this category as they rigidly connect the wheels together.

An independent suspension allows wheels to rise and fall on their own without affecting the opposite wheel. Suspensions with other devices, such as sway bars that link the wheels in some way are still classed as independent.

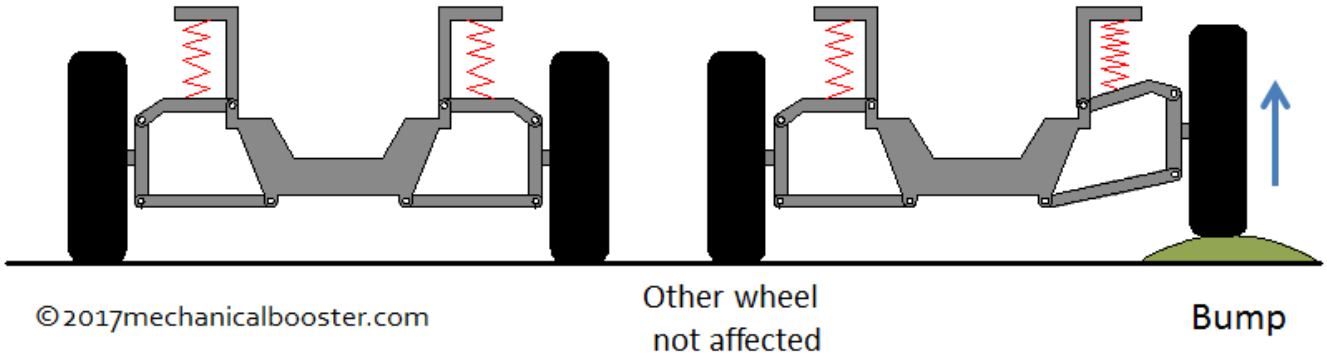
A third type is a semi-dependent suspension. In this case, the motion of one wheel does affect the position of the other but they are not rigidly attached to each other. A twist-beam rear suspension is such a system.

1. Conventional Suspension System:

- Two wheels are mounted on either side of the rigid axle
- When one wheel encounters the bump, both the wheel do not execute parallel up and down motion
- So it gives rise to gyroscopic effect and wheel wobble
- Rear driving wheels mounted on live axle suspended by laminated leaf springs and shock absorbers

2. Independent Suspension System:

- Both the front and the rear wheel are utilized
- Design incorporated in the front wheels
- One wheel goes down, the other wheel does not have much effect
- Basic classification of the design
    a. MacPherson Strut
    b. Double Wishbone
    c. Multi-link
    d. Vertical Guide type



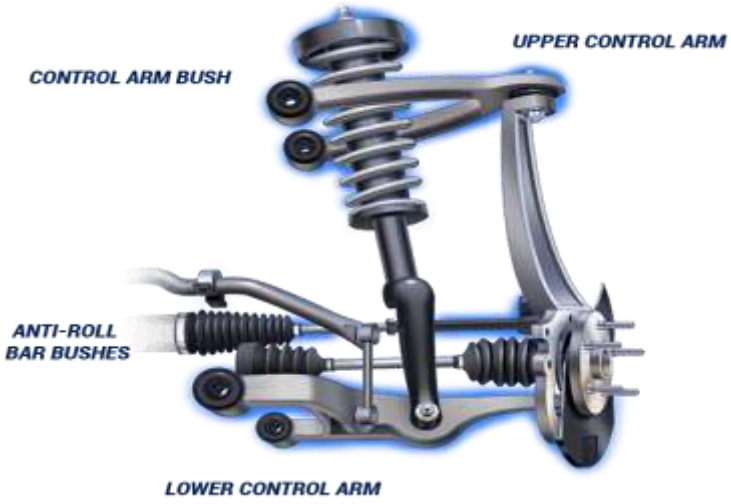
Independent Suspension

a. MacPherson Strut:

- The most widely used front suspension system in cars
- Comprises of a strut-type spring and shock absorber combo, which pivots on a ball joint on the single, lower arm.
- The steering gear is either connected directly to the lower shock absorber housing, or to an arm from the front or back of the spindle (in this case when you steer, it physically twists the strut and shock absorber housing (and consequently the spring) to turn the wheel.

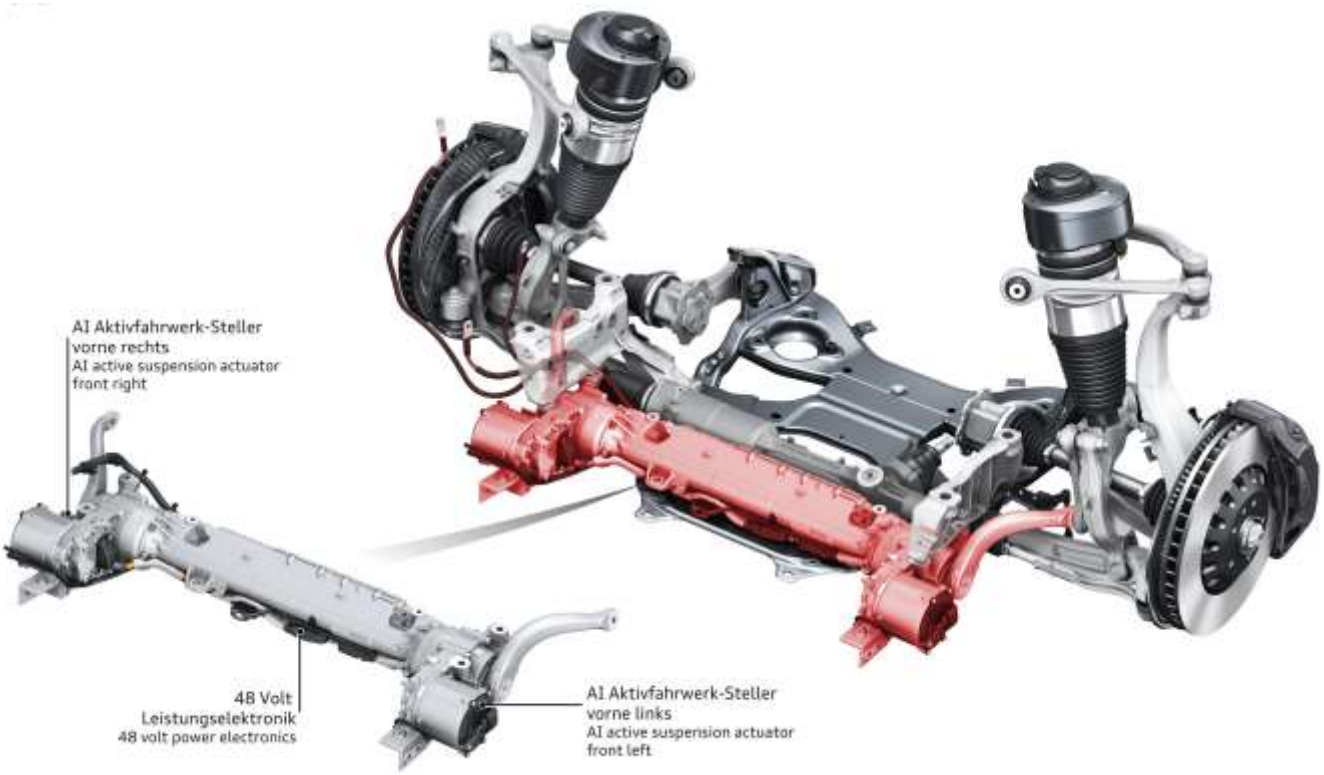
b. Double Wishbone Suspension:

- Type of double-A or double wishbone suspension
- Wheel spindles are supported by an upper and lower 'A' shaped arm.
- Wheel spindles are supported by an upper and lower 'A' shaped arm.
- If you look head-on at this type of system, parallelogram system that allows the spindles to travel vertically up and down.
- This side-to-side motion is known as scrub
- Type of double-A arm suspension although the lower arm in these systems can sometimes be replaced with a single solid arm (as in my picture).
- The spring/shock combo is moved from between the arms to above the upper arm.
- This transfers the load-bearing capability of the suspension almost entirely to the upper arm and the spring mounts.
- The lower arm in this instance becomes a control arm.



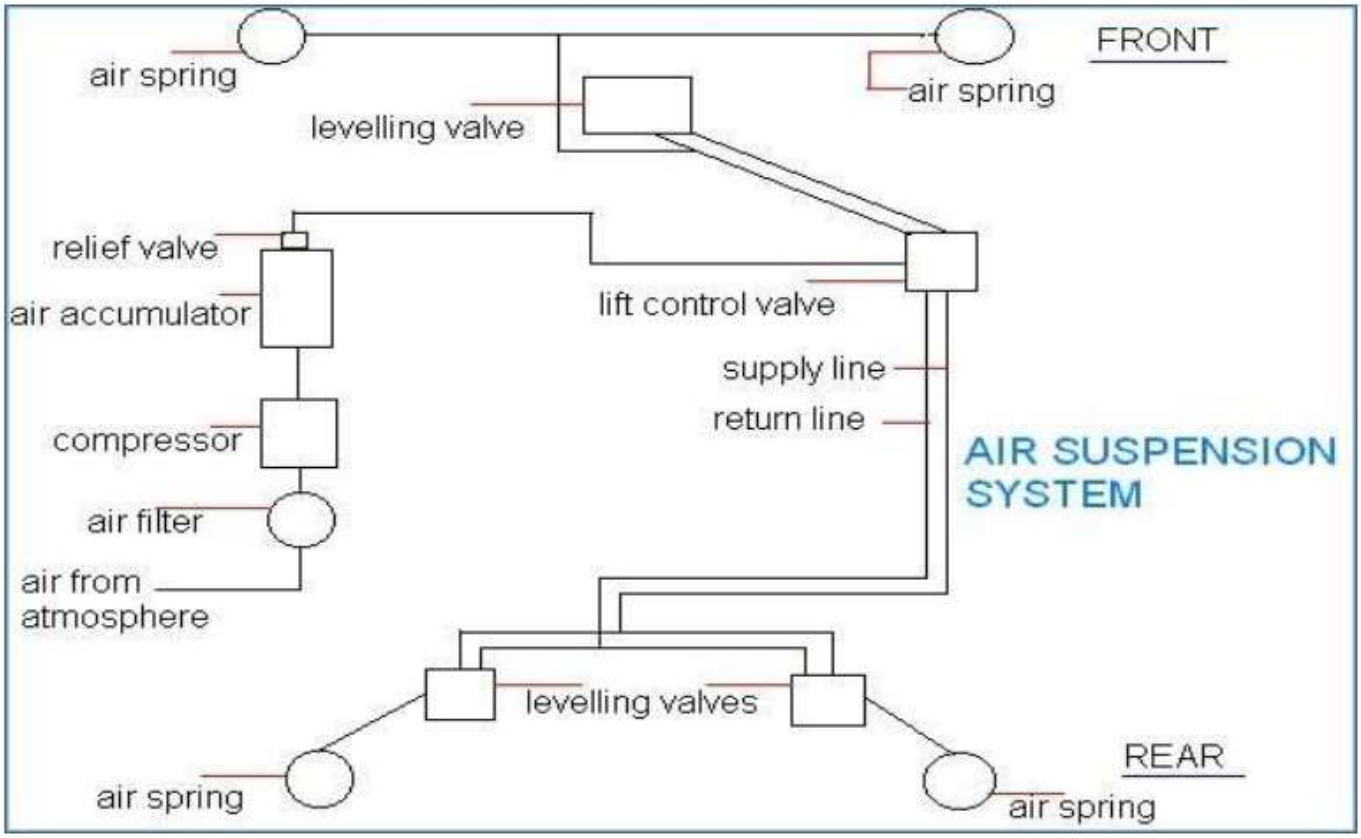
c. Multi-Link Suspension:

- It's currently being used in the Audi A8 and A4 amongst other cars.
- The basic principle of it is the same, but instead of solid upper and lower wishbones, each 'arm' of the wishbone is a separate item.
- These are joined at the top and bottom of the spindle thus forming the wishbone shape.
- The super-weird thing about this is that as the spindle turns for steering, it alters the geometry of the suspension by torqueing all four suspension arms.
- Spring is separate from the shock absorber.



d. Air Suspension:

- Comprises of compressor, suppling air to air tank
- Pressure maintained – 5.6 to 7 kg/sq.
- Air bags – on each wheel
- As load applied, air bags compressed actuating the levelling valve.
- Air from the tank fills the compressed air bag & hence raise the level of the frame.
- Air from air bag gets released as load on chassis decreases.



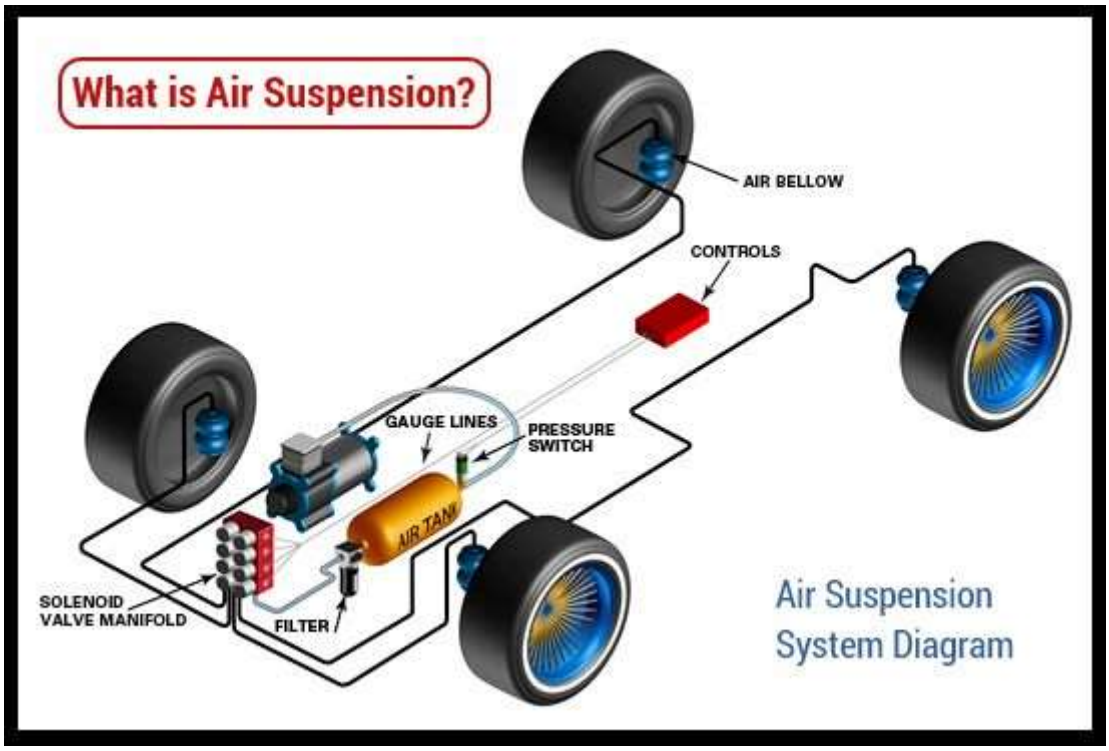
ADVANTAGES OF AIR SUSPENSION:

- These maintain a constant frequency of vibration whether the vehicle is laden or unladed.
- Constant frame height is maintained.
- It helps to reduce the load while the vehicle in motion i.e. the dynamic loading as the spring rate variation between laden and unladed weight is much less.
- It gives smooth and comfort ride of the vehicle.
- The stiffness of the system increases with the increase of the deflection.

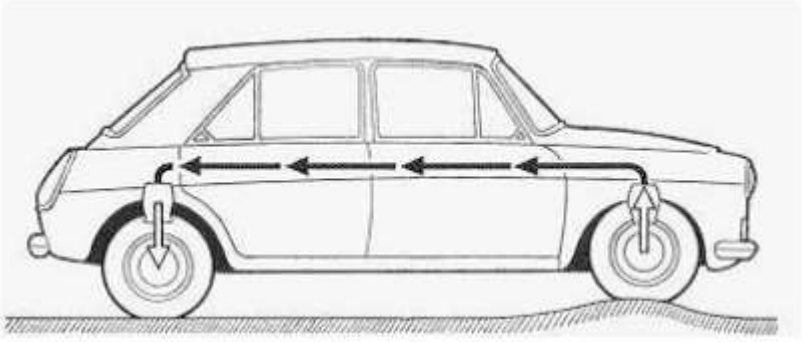
COMMON AIR SUSPENSION PROBLEM:

- Air bag or air strut failure:
- Due to old age, or moisture within the air system that damages them from the inside.
- Compressor failure:
- Primarily due to leaking air springs or air struts

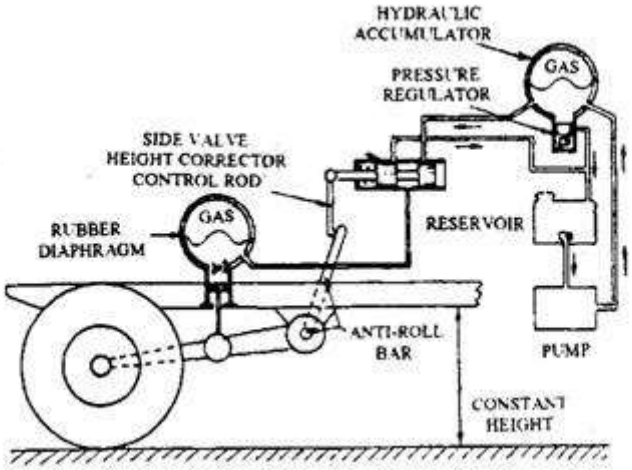
- Compressor burnout may also be caused by moisture from within the air system coming into contact with its electronic parts.
- Dryer failure:
- Which functions to remove moisture from the air system eventually becomes saturated and unable to perform that function.



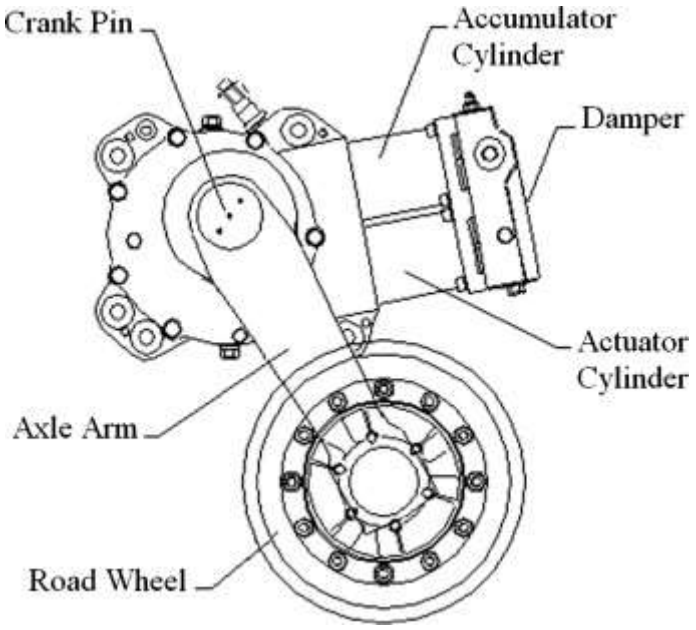
e. Hydro-elastic Suspension:



- a system where the front and rear suspension systems were connected together in order to better level the car when driving.
- The front and rear suspension units have Hydro-elastic displacers, one per side.
- These are interconnected by a small bore pipe. Each displacer incorporates a rubber spring
- Damping of the system is achieved by rubber valves.
- when the front wheel encounter bumps, the piston moves upwards pressurising the fluid to enter into the rear unit.
- Hydro-elastic was eventually refined into Hydro-gas suspension.



f. Hydro-gas Suspension:



- Known as hydro-pneumatic suspension.
- The difference is in the displacer unit itself.
- In the older systems, fluid was used in the displacer units with a rubber spring cushion built-in.
- With Hydro-gas, the rubber spring is removed completely.
- The fluid still exists but above the fluid there is now a separating membrane or diaphragm, and above that is a cylinder or sphere which is charged with nitrogen gas.
- The nitrogen section is what has become the spring and damping unit whilst the fluid is still free to run from the front to the rear units and back.