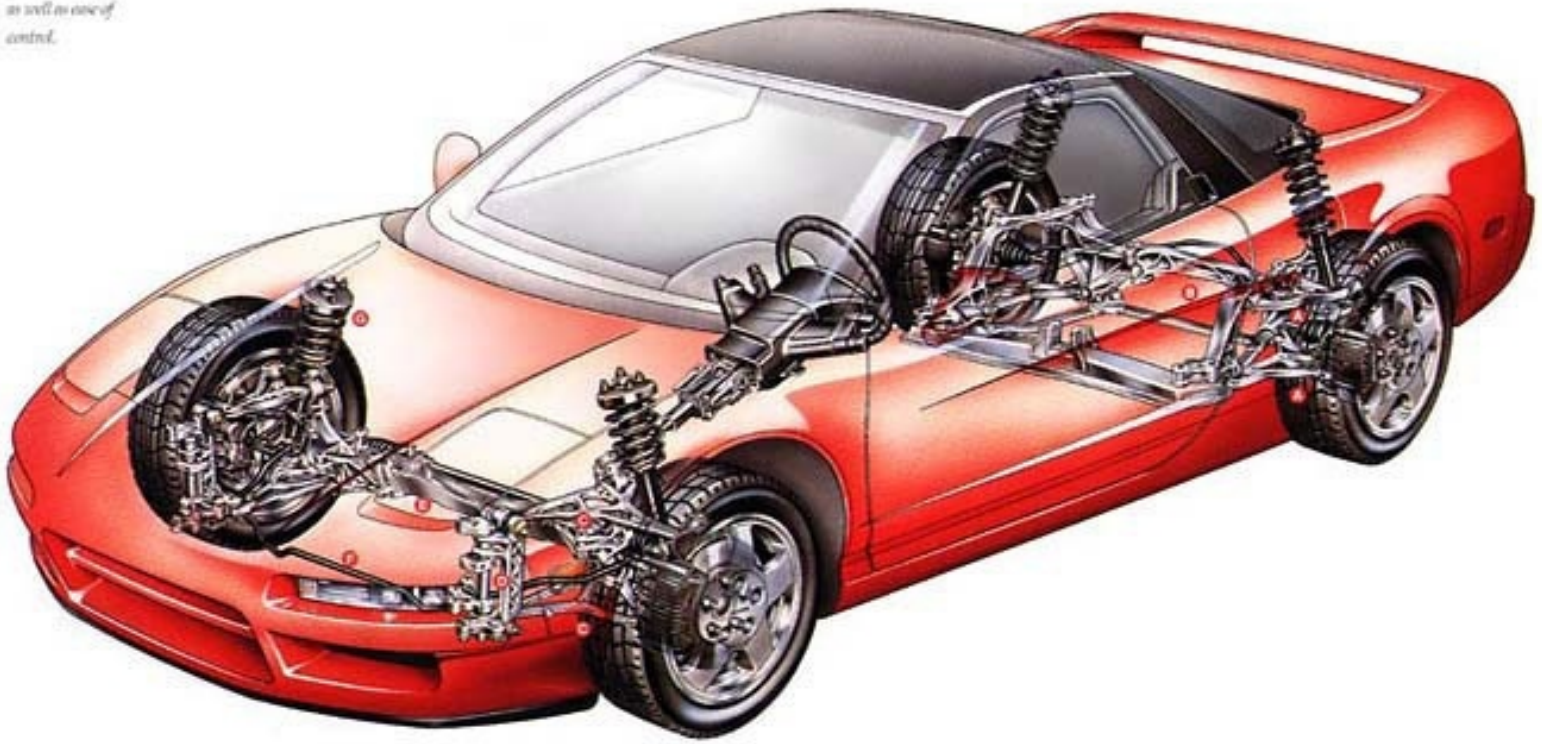
Suspension System

UNIT V

Suspension System

- The frame as well body of the vehicle is attached to the rear axle and the front axle by springs. These springs damp the road shock transmitted to the body structure by the wheels when they travel over the road.
- In this way the springs are the protecting units supported directly by the frame of the vehicle
- Therefore all the parts which perform the function of isolating the automobile from the road shocks are collectively called a suspension system.

The suspension system is designed to provide world-class handling as well as ease of control.



Objects of Suspension system

- To prevent the road shocks from being transmitted to the vehicle components.
- To safeguard the occupants from road shocks.
- To preserve the stability of vehicle in pitching or rolling, while in motion.

Types of suspension

- The front-end suspension
- Rear end suspension.

Independent Suspension

- When a vehicle with rigid axle suspension encounters road irregularities, the axle tilts and the wheels no longer remains vertical.
- This causes whole of the vehicle to tilt on one side.
- To avoid this the wheels are sprung independent of each other , so that tilting of one does not effect the other.

Advantages of Independent suspension over rigid axle suspension

- In case of independent suspension lighter and softer springs can be used.
- Unsprung weight is reduced(Weight of the vehicle components between the suspension and the road surface ex. Rear axle assembly , wheels , tyres , brakes etc) which ultimately reduces the tyre scrub and hence increases tyre life.
- With independent suspension , Steering geometry is not altered with spring deflection.(spring defection affects the caster angle, especially when braking or accelerating.)
- In this the engine and chassis frame can be placed relatively lower which means engine position can be moved forward resulting in more space for passengers.

- Independent suspension has become almost universal in the case of front axle due to the simplicity of construction of such a suspension system.
- In this type of suspension, each front wheel is independently supported by a coil, torsion bar or leaf spring.
- Almost all the passenger cars now use the independent front suspension. in which the **coil spring** arrangement is the most common.

Front wheel Independent suspension

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Types of FVIS

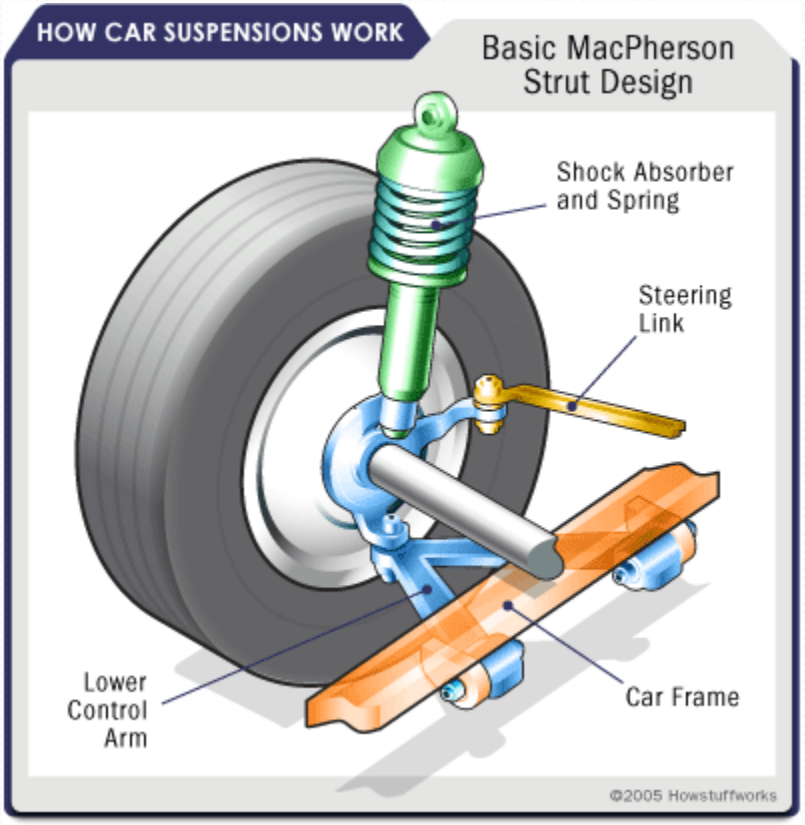
1. Wishbone type or parallel link type
2. Mac Pherson strut type
3. Vertical guide type.
4. Trailing link type.
5. Swing half-axle type.

Wishbone type suspension

- It consist of upper and lower wishbone arms pivoted to the frame member.
- The spring is placed in between the lower wishbone and the underside of the cross member.
- The vehicle weight is transmitted from the body and the cross member to the coil spring through which it goes to the lower wishbone member.
- A shock absorber is placed inside the coil spring and is attached to the cross-member and to lower wishbone member.

- The wishbone arms are like chicken wishbone or letter V in shape , because of which the system is so called.
- Because of this V-shape , the wishbones not only position the wheels and transmit the vehicle load to the springs , but these also resist acceleration , braking and cornering(side) forces
- The upper arms are shorter in length than lower ones , this helps to keep the wheel track constant , thereby avoiding the tyre scrub thus minimizing the tyre wear.

The **MacPherson strut type of suspension**



Mac pherson strut type suspension

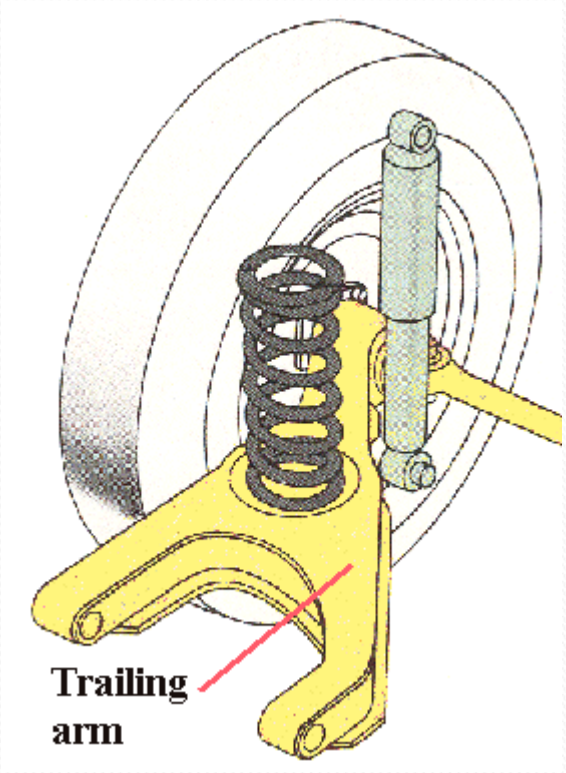
- In this layout only lower wishbone are used. A strut containing shock absorber and the spring carries also the stub axle on which the wheel is mounted.
- The wishbone is hinged to the cross member and positions the wheel as well as resists acceleration , braking and side forces.
- The system is simpler than double wishbone type and is also lighter keeping the unsprung weight lower.
- **The camber also does not change when the wheel moves up and down**

- This type of suspension gives maximum room in the engine compartment and is therefore commonly used on front wheel drive cars.

Vertical guide suspension

- The king pin is attached directly to the cross member of the frame.
- It can slide up and down corresponding to the up and down motion of the wheel , thus compressing or elongating the spring.
- In this track wheel base and wheel attitude remain unchanged , but the system is having disadvantage of decreased stability.

Trailing link suspension



Trailing link suspension

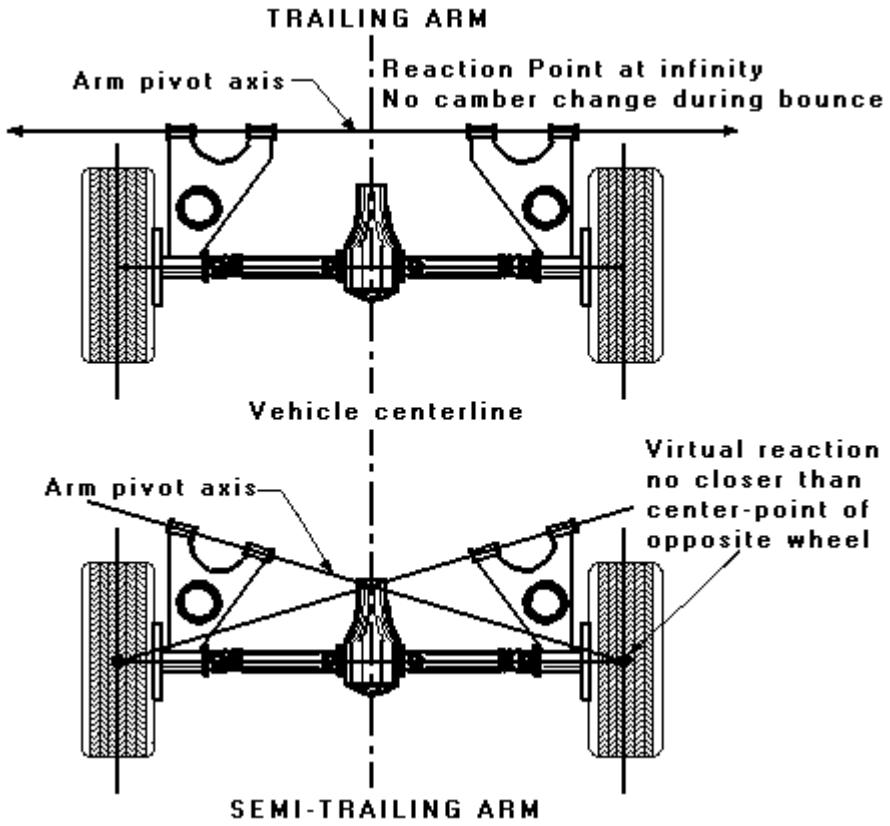
- In this type of suspension , a coil spring is attached to the trailing link which itself is attached to the shaft carrying the wheel hub.
- When the wheel moves up and down , it winds and unwinds the spring.
- this system does maintain the camber and the wheel track constant.

Swinging half axle suspension

- In this , wheels are mounted rigidly on the half axles which are pivoted on their ends to the chassis member at the middle of the car.
- The main disadvantage of this system is that up and down movement of the wheels cause the camber angle to vary.

Swinging half axle suspension

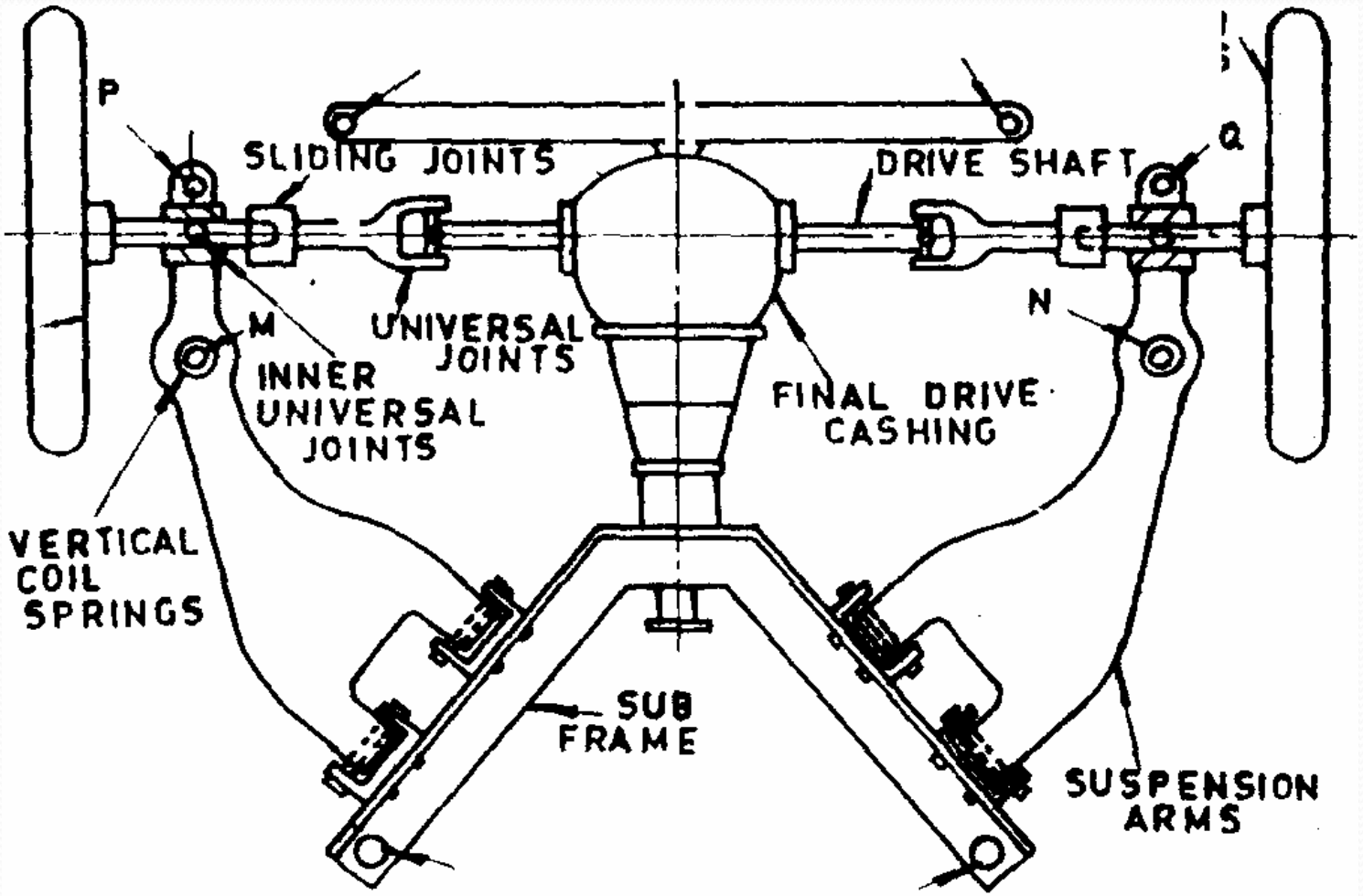
FIGURE 18: TRAILING ARM AND SEMI-TRAILING ARM



Disadvantages of Independent suspension

- The initial cost is high
- Greater maintenance is required.
- Misalignment of steering geometry with the wear components , thus requiring more frequent attention.
- More rigid sub- frame or chassis frame required

REAR WHEEL INDEPENDENT SUSPENSION



- The rear wheels of the general vehicles are power driven therefore considerable difficulties are there to provide independent suspensions.
- But looking some advantages of independent rear suspensions over the rigid axle type it is used in some vehicles.

- Referring Fig. M and N are two coil springs in vertical positions and are mounted on the suspension arms
- The arms are jointed on rubber bushes carried by the sub-frame. The sub frame incorporates Rear Wheel Independent Suspension the final drive casing which is mounted on the body structure on the four rubber mountings A, B, C .and D.
- The other ends of the suspension arms are connected with the drive shafts in such a way that the shafts may be housed inside the ends with universal drives.
- One sliding joint is also provided between the two universal joints.

Types of suspension springs

The various springs may be classified as follows:

1)Steel Springs.

i. Leaf spring
ii. Tapered leaf spring
iii. Coil spring
iv. Torsion bar

2) Rubber Springs

i. Compression spring
ii. Compression –shear spring
iii. Steel- reinforced spring
iv. Progressive spring
v. Face shear spring
vi. Torsional shear spring

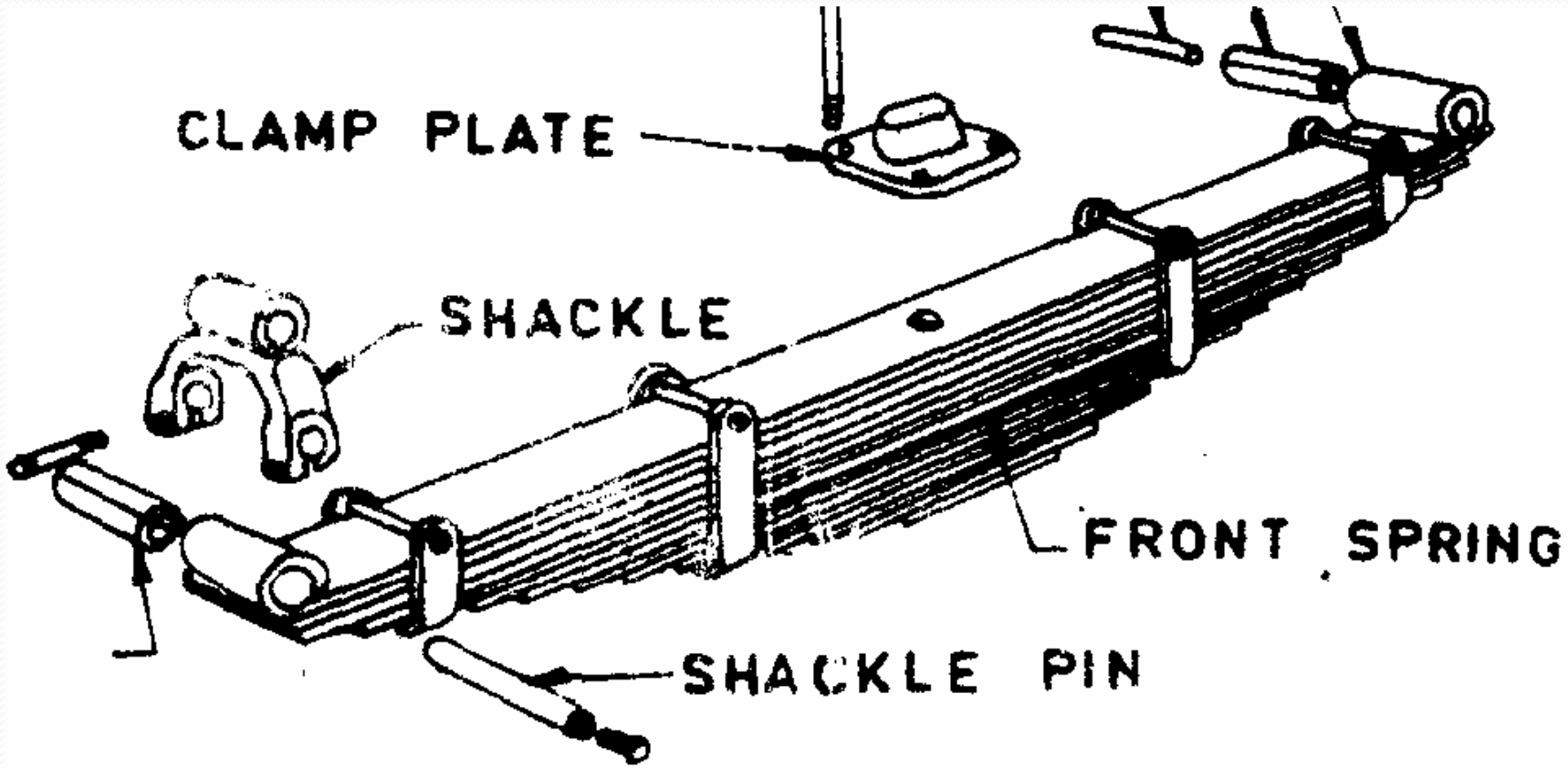
3) Plastic spring
4) Air spring
5) Hydraulic spring

LEAF SPRINGS

- Semi-elliptical leaf springs are almost universally used for suspension in light and heavy and commercial vehicles.
- Longitudinal leaf spring suspension is generally used in conjunction with the Hotchkiss drive.
- The leaf springs must be made strong and resilient enough to transmit the driving thrust and torque and to resist side ways, in addition to support the spring weight of the body.
- The spring weight is kept as less as possible

- Because the springs do not generally support the wheels, rims , tyres, brakes and rear axle, the weight of these parts is called unsprung weight. is clamped to the rear axle housing by U-bolts, its each end is pivoted to the frame, by means of eyes formed in the ends of the longest leaf.

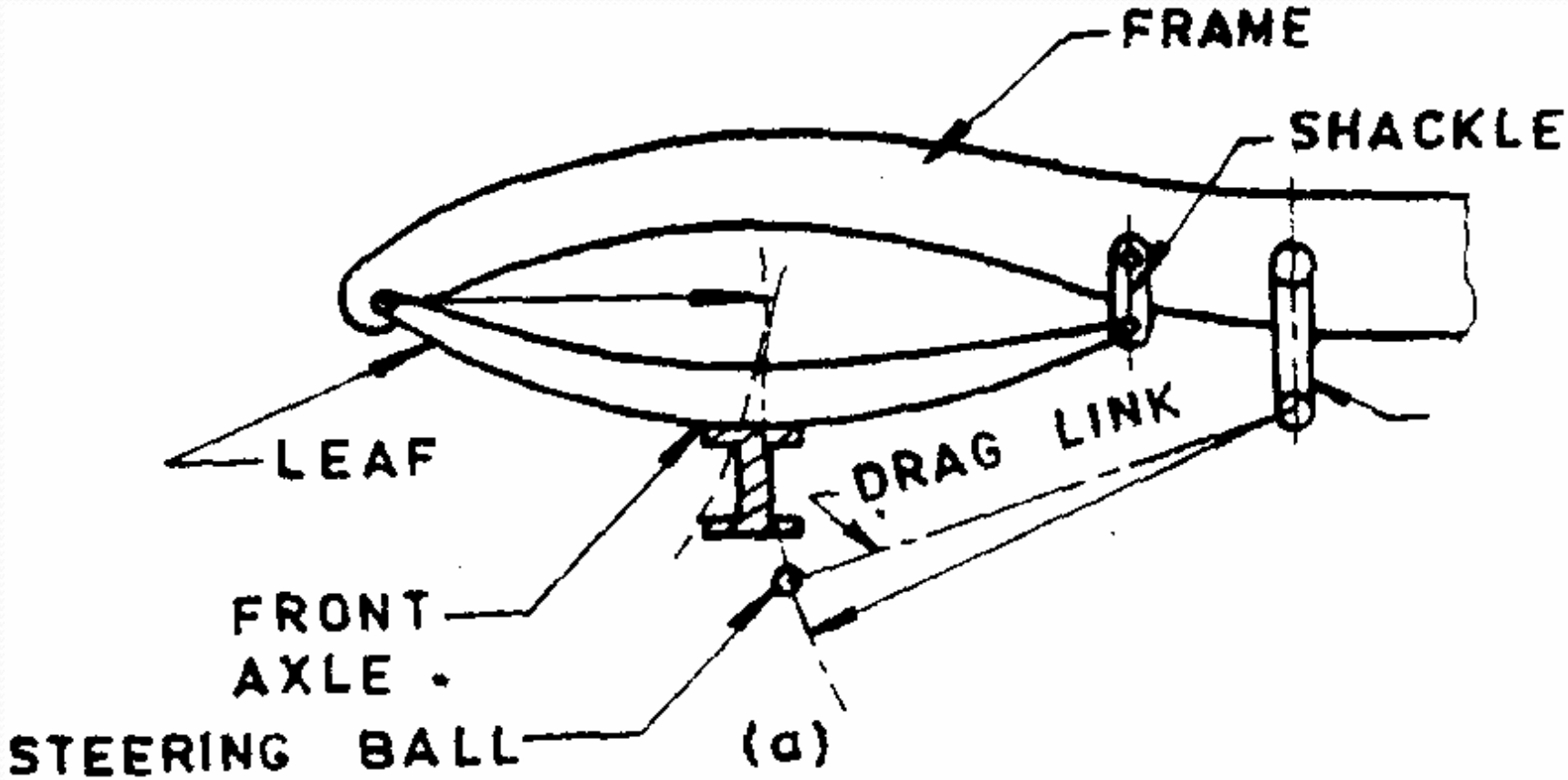
- The spring consists of a number of leaves called blades. These blades vary in length. The composite spring is based upon the theory of a beam of uniform strength.
- The lengthiest blade has eyes on its ends. This blade is called, master leaf. All the blades are bound together by means of steel strips.


CLAMP PLATE
SHACKLE
FRONT SPRING
SHACKLE PIN

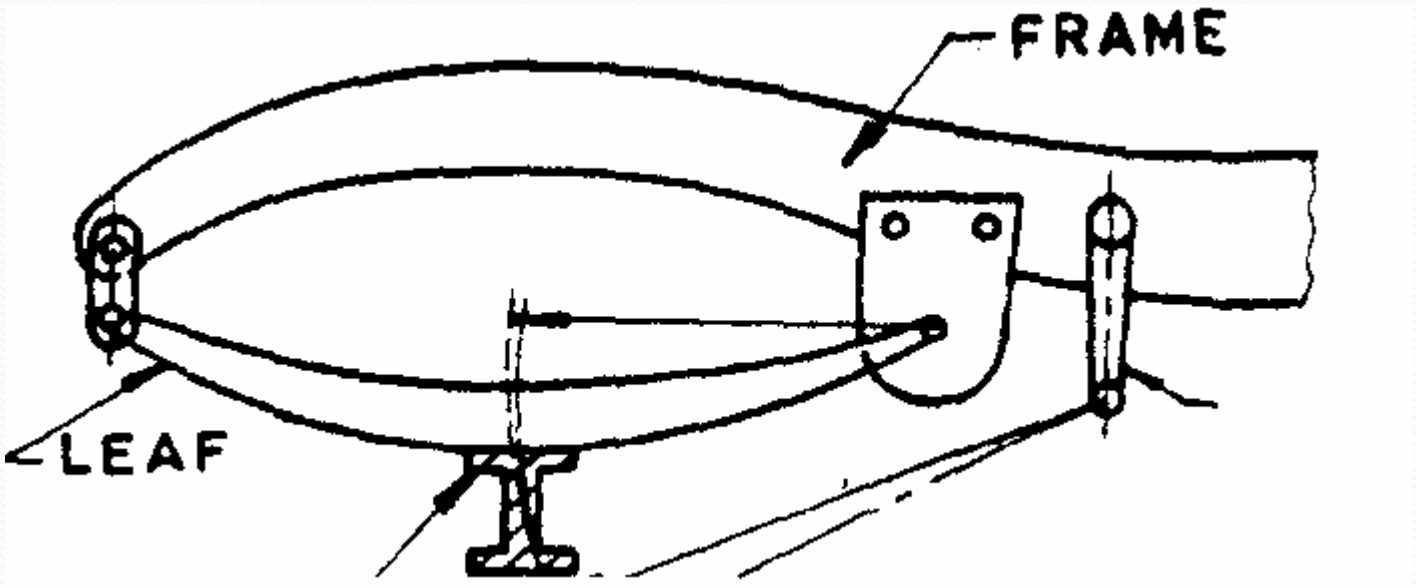
- The spring is supported on the axle, front or rear. One end of the spring is mounted on the frame with a simple pin, while on the other end, connection is made with a shackle.
- The spring elongates in compression and shorten in expansion, This change in length of the spring is compensated by the shackle
- At the intermediate position of the spring length, the rebound clips are located. They are loose enough to permit the leaves to slide one on the other, and yet tight enough to hold these leaves together when the spring rebound.
- The spring eyes are usually provided with bushings or some anti frictional material such as bronze or rubber

- Shackles are a sort of links by means of which leaf springs are connected with the chassis frame.
- The shackles provide swinging ability to the leaf springs. Due to shock on the road wheel, the spring flattens up and increase in length rebound the spring assumes back shape there by in length. The shackles make the springs swing in and out.
- One end of the link is connected with the chassis frame and through the end connection is made with the spring by means of the shackle bolt or pin.

Shackle at rear end



Shackle at front end



TORSION BAR

- Torsion bar is simply a rod acting in torsion and taking shear stresses only.
- These are made of heat treated alloy spring steel.
- The amount of energy stored per unit weight of material is nearly the same as for coil springs. Torsion bars are often used will independent front suspensions. Hence it is termed torsion bar front independent suspension.
- The bar is fixed to the frame, while the other end is fixed to the end of wheel arm and supported the bearing. The other end of the wheel arm is connected to the wheel hub.

- When the wheel strikes a bump, it starts vibrating up and down, thus exerting torque on the torsion bar, which acts as a spring.
- Torsion bar spring is lighter as compared to leaf springs and also it occupies less space.

Disadvantages of the torsion bar suspension

- There are two main disadvantages of the torsion bar suspension.
- The first is that it does not take the braking or driving torque so that additional linkages have to be provided for that purpose.
- The second disadvantage is the absence of friction force, and hence of damping which is a necessity to control the vibrations produced due to road.

Shock Absorbers

- A springing device must be a compromise between flexibility and stiffness.
- If it is more rigid , it will not absorb road shocks efficiently and if it is more flexible it will continue to vibrate even after the bump has passed.
- So we must have sufficient damping of spring to prevent excessive flexing
- Friction between the leaves of a leaf spring provides this damping , but because of uncertainty of lubrication conditions , the amount of friction also varies and hence damping characteristics do not remain constant.
- For this reason ,the friction between springs is reduced to minimum and additional damping is provided by means of devices called **dampers or shock absorbers**
- **Shock absorber** thus control excessive spring vibration.
- It is a device which introduces resistance to the motion of the spring and road wheel so as to damp out vibrations

Types of shock absorbers

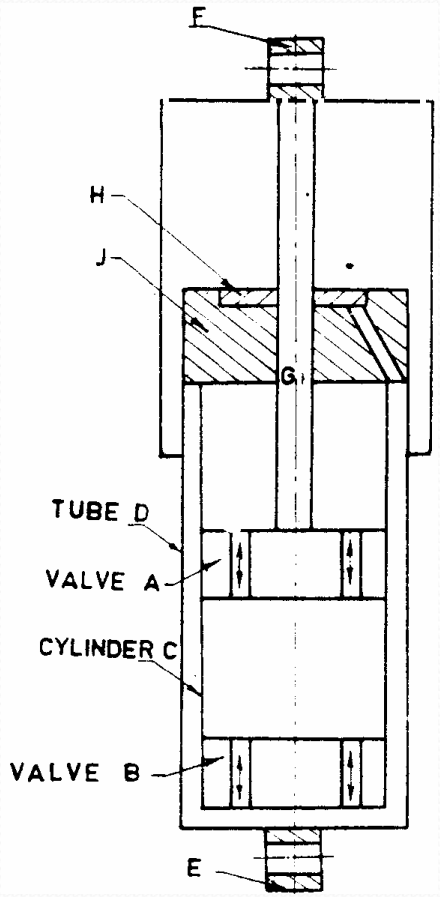
- Friction type
- Hydraulic type

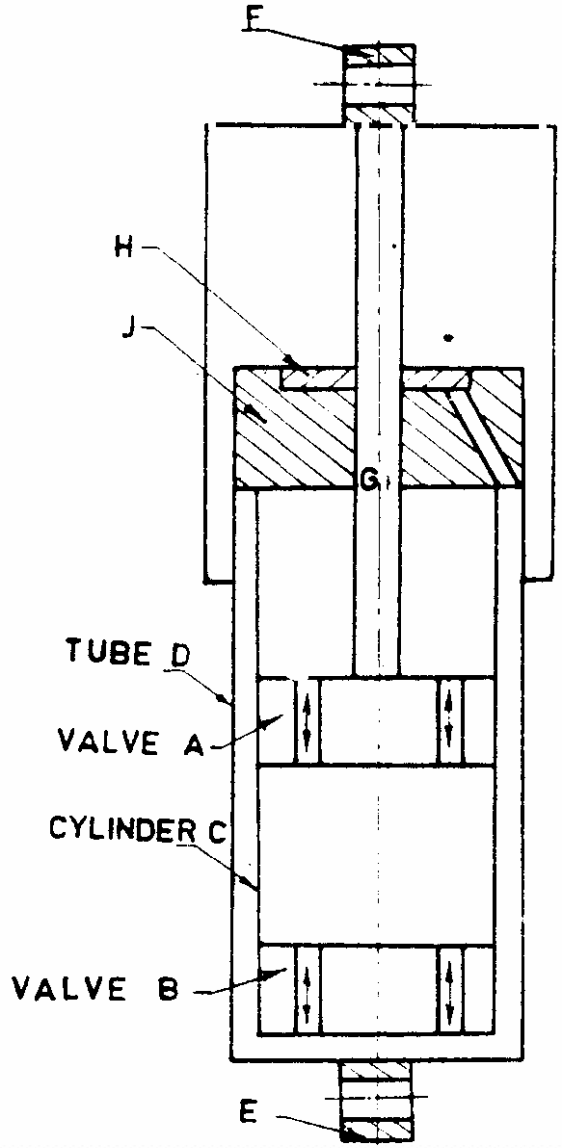
- Friction type: Almost become obsolete because of non predictable damping characteristics.
- Hydraulic shock absorber: principle of operation:

When the piston forces the fluid in a cylinder to pass through some hole , a high resistance to the movement of piston is developed , which provides damping effect.

- The advantage of the fluid type is that the fluid resistance is proportional to the square of the speed and so increases rapidly with the speed of the suspension movement.

Telescopic type shock absorber





- The device consists of two valves, A and B. Rod G is attached to the two way valve A. while another, similar two-way valve B is attached at the lower end of cylinder C.
- There is fluid in the space above valve A, below valve A and also in the annular space between cylinder C and tube D, which is connected to the space below the valve B.
- H is a gland in the head J and any fluid scrapped off by rod G is brought down into the annular space through the inclined passage shown in head.
- The eye E is connected to the axle. While the eye F is attached to chassis frame.
- The fluid generally used in shock absorbers is a mixture of 60 percent transformer oil and 40 percent turbine oil.

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ACTION OF THE SHOCK ABSORBER

- When the vehicle has come across a bump, then eye E would move up and there by the fluid will pass from the lower side of valve A to its upper side.
- But since the volume of the space above A is less by the volume of the rod G, the fluid will also exert its pressure on the valve assembly B and go to underside of the valve B.
- This passing of fluid through valve opening provides the damping
- Similarly for downward motion of eye E , the fluid will pass from the upper side of the valve assembly A to lower side of valve assembly B to its upper side.