Vehicle servicing and repairing

NTQF Level II

Learning Guide #27

Unit of Competence: **Maintain and Repair Under Chassis Systems**

Module Title: Maintaining and Repairing Under Chassis Systems

LG Code: **EIS VSR2 M08 0919 LO1-LG 27**
TTLM Code: **EIS VSR2 TTLM 0919V1**

LO1. Prepare to undertake maintenance and repairs to under chassis systems

Instruction Sheet	Learning Guide #27

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics –

- Analyze suspension, brake and steering system
- Identify nature and scope of work
- WHS requirement
- Source procedures and information
- Select and prepare Method options
- Source and support technical and/or measurement
- Observe warnings

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to –**

- ❖ The suspension, brake and steering system fitted to the vehicle are analyzed
- ❖ Nature and scope of work requirements are identified and confirmed
- ❖ WHS requirements, including individual state/territory regulatory requirements and personal protection needs are observed throughout the work
- ❖ Procedures and information such as workshop manuals and specifications, and tooling, are sourced
- ❖ Method options are analyzed and those most appropriate to the circumstances are selected and prepared
- ❖ Technical and/or measurement requirements for chassis systems are sourced and support equipment is identified and prepared
- ❖ Warnings in relation to working with wheeled are observed

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described in number 3 to 6.
3. Read the information written in the “Information Sheets 1, Information Sheets 2, Information Sheets 3, Information Sheets 4, Information Sheets 5, Information Sheets 6 and Information Sheets 7”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-check 1, Self-check 2, Self-check 3, Self-check 4, Self-check 5, Self-check 6, Self-check 7” **in page - .34,36,38,40,48,50 and 52 respectively**
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-check).
6. If you earned a satisfactory evaluation proceed to “Information Sheet 2”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity #1.

Information Sheet-01	Analyze suspension, brake and steering system

1.1.1. Suspension

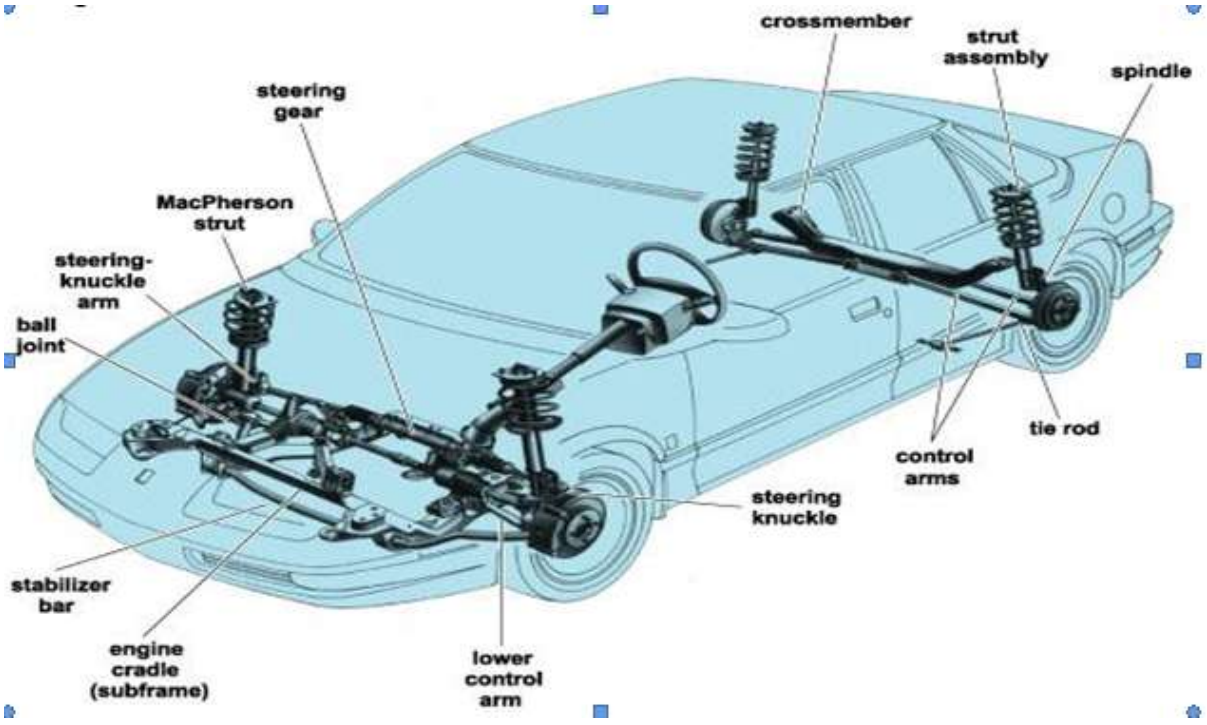
The Automobile Chassis is mounted on the axles, not direct but through some form of springs. This is to isolate the vehicle body from the road shocks which may be in the form of bounce pitch, roll or sway. These tendencies give rise to on uncomfortable ride and also cause additional stress in the automobile frame and body. All the parts which perform the function of isolating the automobile from the road shocks are collectively called a suspension system. It includes the springing device used and various mountings for the same.

Broadly speaking, suspension system consists of a spring and a damper. The energy of road shock causes the spring to oscillate. These oscillations are restricted to a reasonable level by the damper, which is more commonly called a shock absorber.

Location of the suspension system is between the wheel axles and the vehicle body or frame. Its main purpose is:-

i) To prevent the road shocks from being transmitted to the vehicle components and occupants.
ii) Support the weight of the vehicle
iii) Maintain traction between the tires and the road
iv) Hold the wheels in alignment

Many different suspension systems are in use. Most of them provide an acceptable degree of road ability and riding comfort. All use some sort of springs or other shock absorber devices.



Rigid axle suspension

In rigid axle suspension, a wheel is mounted at each end of a solid, or undivided, axle or axle housing. This type of suspension has the advantages of strength and low cost, but it provides less efficiency and comfort than independent suspension.

Most passengers cars use rigid axle suspension only at the rear. Rigid-axle front suspension systems are usually found only on heavy duty vehicles and trucks. Since the axle connects with wheels, any condition that affects one wheel affects the other. Incase one wheel is raised by a bump in the road, the axle will be tilted. Thus the motion of the raised wheel is passed to the other wheel. Since the frame of the car is attached to the axle, the car body is also tilted.

A rigid axle suspension has the following characteristics:

- The number of parts composing the suspension is small and the construction is simple. Therefore, maintenance is simple.
- It is durable enough for heavy-duty use.
- When turning there is little tilting of the body.
- There is little change in the alignment due to the up and down movements of the wheels. Therefore, there is less tyre wear.
- Since the unsprang weight is great, riding comfort is poor.
- Since the movements of the left and right wheels mutually influence one another, vibration and oscillation occur rather easily.

There are various types of rigid axle suspension. Below will be discussed rigid axle suspension used at present in Toyota vehicles.

1) Parallel leaf spring type

This type of suspension is used for the front suspension of trucks and buses, etc, and for the rear suspension in commercial vehicles.

Characteristics

- Since the leaf spring also acts as a linkage for positioning the axle (holding in place), separate linkages are generally unnecessary. Therefore the construction of the suspension is simple but comparatively strong.
- Since the positioning of the axle is carried out by the leaf springs it is difficult to use a very soft spring (a spring with a low spring constant). Therefore, this type of suspension is not very good with respect to riding comfort.
- Riding comfort suffers due to inter-leaf friction in the leaf springs. Acceleration and braking torque tend to causes wind-up and vibration and wind-up in turn causes rear- end squat and nose-diving.

2) Leading arm and trailing arm types with lateral rods

This type of suspension is used for the front and rear suspension of the land cruiser.

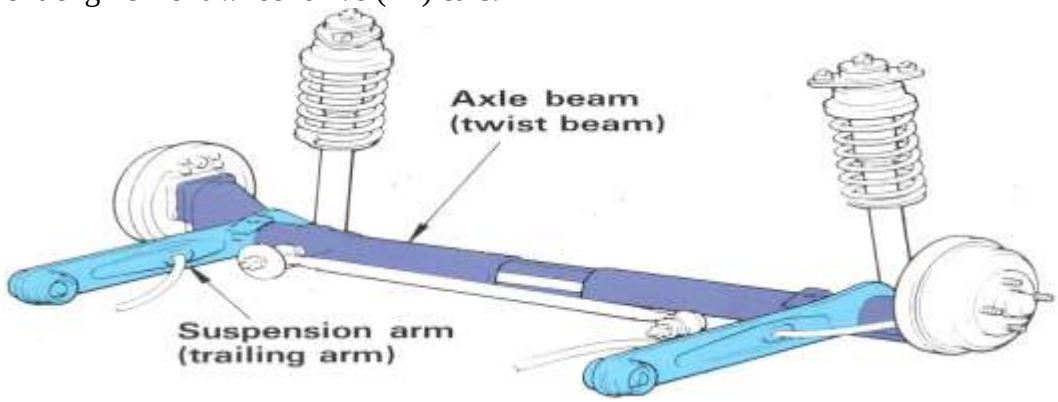
Characteristics

In this type, the positioning of the axle, which is accomplished by the leaf springs in the previously parallel leaf spring type, is instead accomplished by leading arms or trailing arms and a lateral control rod. It is superior to leaf springs in the following points.

- Since the spring constant can be made smaller riding comfort is good.
- Since the trailing arm's rigidity is high, it is difficult for wind-up to occur.

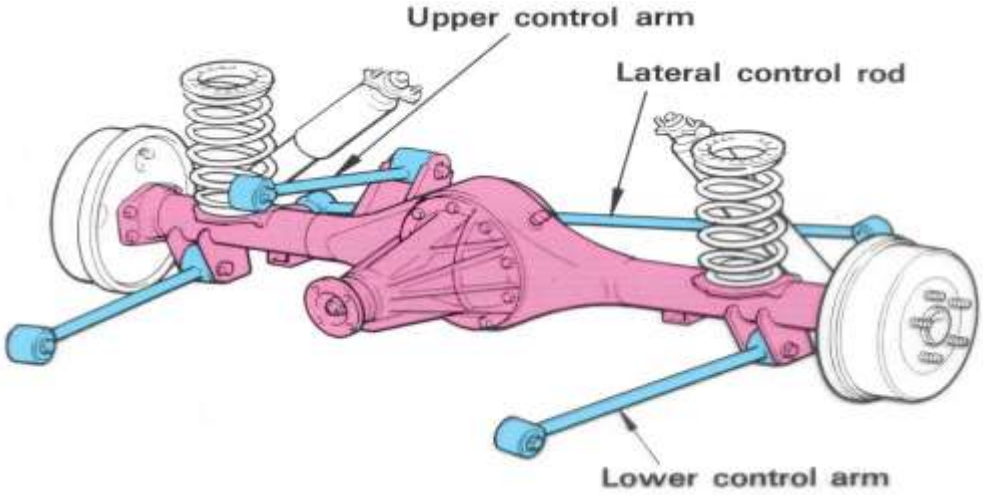
3) Trailing arm type with twist beam

The construction of this type is simple and it is compact, so it is used for the rear suspension of front engine front wheel drive (FF) cars.



4. Link type

This type is used for the rear suspension. It provides the best riding comfort of all the rigid axle suspension.



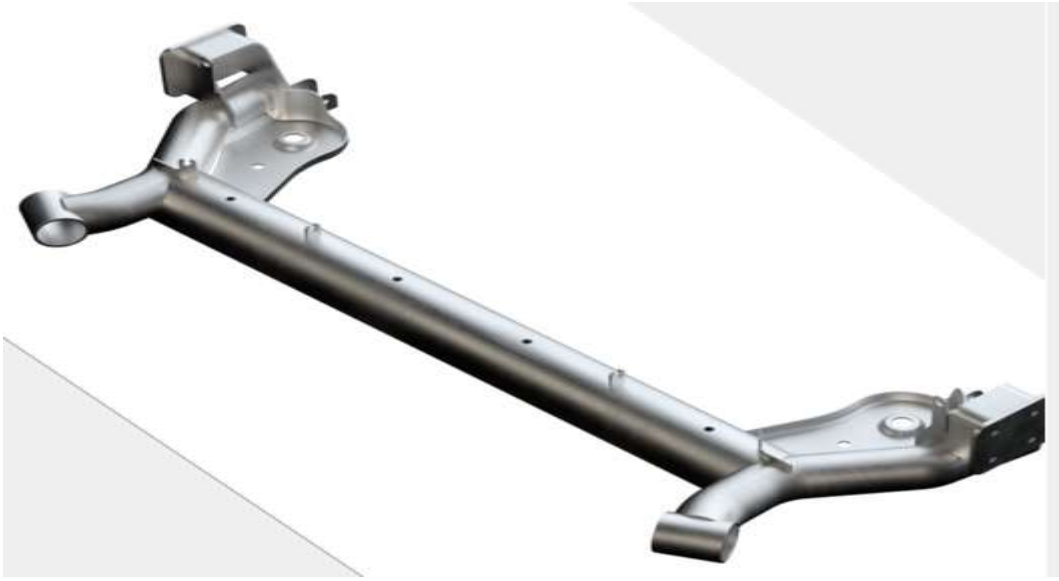
Characteristics

- Since axle positioning is accomplished by a linkage, soft springs can be used and riding comfort is good.
- Due to the geometrical layout of the linkages, nose diving during braking and rear-end squat during acceleration are prevented. Also the up-and-down movement of the front end of the differential during bounding and rebounding can be minimized by making the upper control arms shorter than the lower control arms. This in turn means that the floor over the nose of the differential can be lowered, allowing more passenger compartment space.

- Use of coil springs minimize friction in the suspension, so minute shocks from the road surface can be absorbed and riding comfort can be improved.
- Generally, when this suspension system is used in the rear, the linkage is located forward of the axle, and as a result, the capacity of the trunk can be larger on passenger cars.

Twist beam axle

A twist-beam axle for motor vehicles, includes two longitudinal control arms, and a transverse strut interconnecting the longitudinal control arms, wherein the transverse strut and/or the longitudinal control arms is/are partially hardened.



Single wheel suspension

The single wheel design provides a slimmer profile, allowing access on narrow single-track and lower rolling resistance. The level frame and fender make securing long and oversized objects to the trailer quick and easy.

Independent

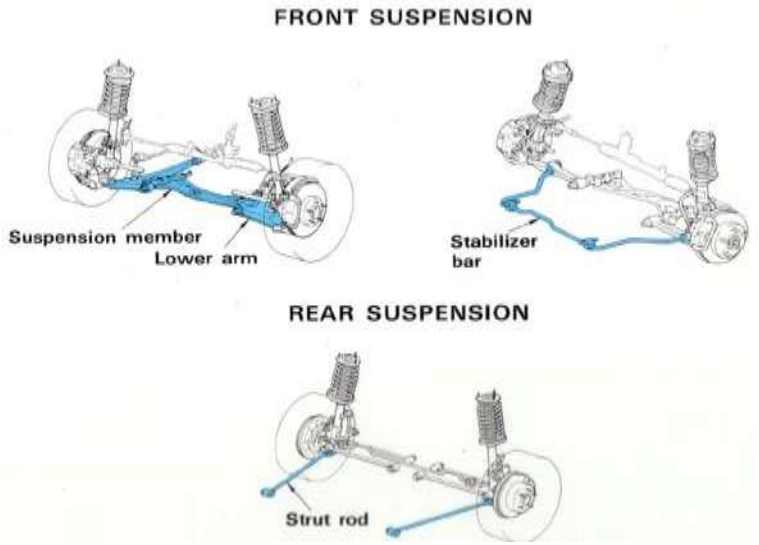
Independent suspension systems provide a separate mounting for each wheel. There is no connection between the wheels as there is when a rigid axle is used. Therefore, the linear motion of one wheel is not transmitted to the other, and there is no tilting of an axle, that in turn, might tilt the entire car.

Most independent front suspension systems use coil springs, There are several methods of mounting the springs. One method is to locate each spring between a lower control arm and the frame; Another method is to locate each spring between an upper control arm and spring tower above the frame. Still another method positions the springs around long shock absorbers. Those units, usually referred to as MacPherson struts, connect the lower control arm to the chassis or under body. Some suspension systems use no springs at all instead, they use torsion bars.

The characteristics of the independent suspension are as follows:

- The unsprung weight can be kept low and the road holding characteristics of the wheels are good, so riding comfort and handling stability is good.

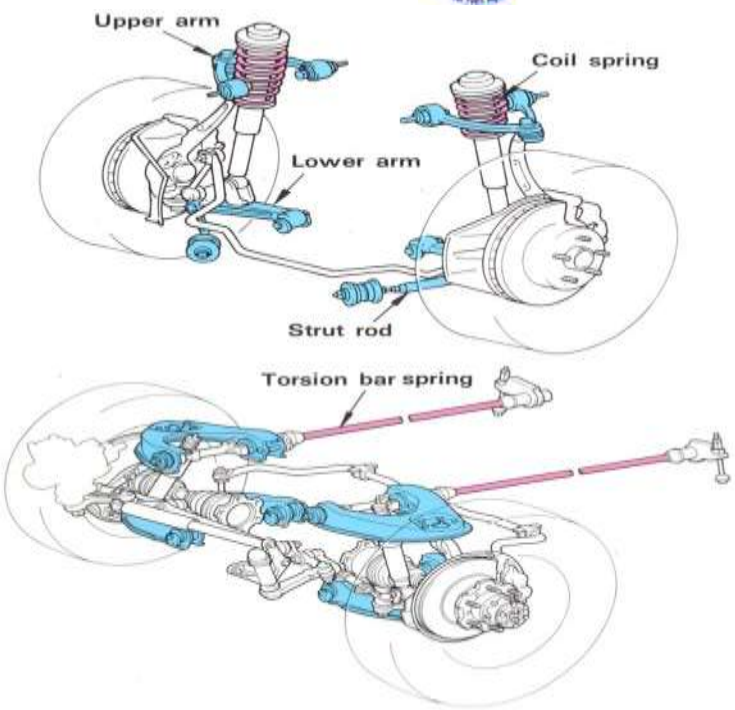
- In independent suspensions, the springs only support the body; they do not help to position the wheels (this is being done by the linkages). This means that softer springs can be used
- Since there is no axle connecting the left and right wheels the floor and the engine mounting position can be lowered. This means that the vehicle's canter of gravity will be lower, and the passenger compartment and luggage room can be made larger.
- The construction is rather complex.
- Tread and alignment change with the up-and-down motions of the wheels.



Double wishbones

This type considers the upper and the lower wishbone arms pivoted to the frame members. The coil spring is placed in between the lower wishbone and the underside of cross-member. The vehicle weight is transmitted from the body and 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 the lower wishbone member.

The wishbone arms are like the 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 the lower ones. This helps to keep the wheel track constant, there by avoiding the tyre scrub, thus minimizing tyre wear. However, a small change in the camber angle does occur with such an arrangement. The wishbone type is the most popular independent suspension system.



Characteristics

The geometry of the arm layout- that is, the length, positions and angles of the arms governs the path of the wheels when the car corners or goes over bumps. This path in turn affects steering, road holding, and tyre wear. If the upper and lower arms were made parallel and of equal length, The wheels would not lean as they move up and down over bumps. This would cause the tread (the distance b/n the left and right wheels) to vary resulting in poor cornering and excessive tyre wear.

Therefore, in most modern suspension systems the arms are made neither parallel nor of equal length. This causes the wheels to lean inward slightly as they go over bumps, so that the tread does not change; and it improves cornering because the outside wheel, which carries the greater load and therefore exerts the greater cornering power of the two, remain more or less at right angles to the road surface, thus improving road holding.

Macpherson

A MacPherson strut suspension uses only one control arm and a strut assembly (spring, damper, and shock absorber unit) to support each wheel assembly the modified strut suspension has the coil spring mounted on top of the lower control arm, not around the strut.

A conventional lower control arm attaches to the frame and to the lower ball joint.

The ball joint holds the control arm to the steering knuckle or bearing support.

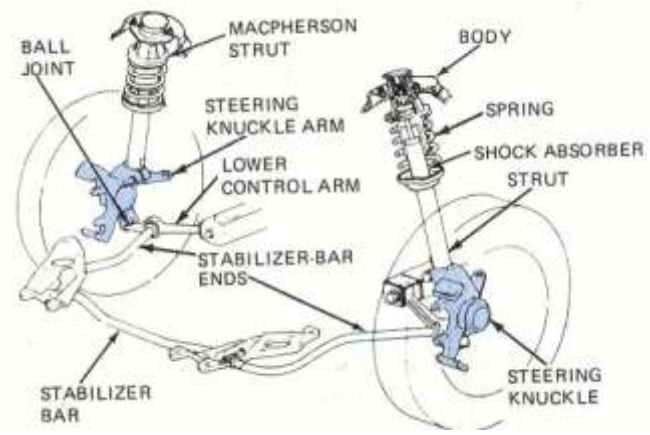
The top of the steering knuckle or bearing support is bolted to the strut assembly.

The top of the strut is fastened to the reinforced body structure,

MacPherson strut suspension is the most common type of suspension found on late-model cars.

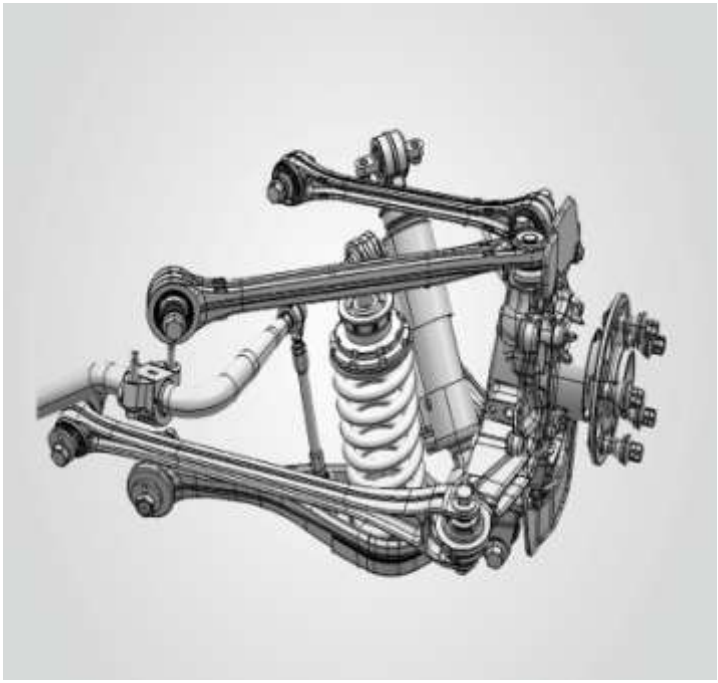
It may be used on both the front and rear wheels.

It reduces the number of parts in the suspension system, lowering the unsprung weight and smoothing the ride,



Multi-link axle

- 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 torquing all four suspension arms.
- Spring is separate from the schock absorber.



1.1.2. Brake system

Hand brake

Parking brake mechanisms

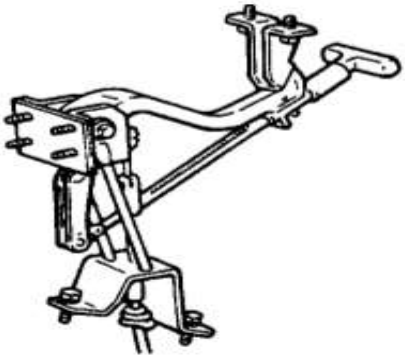
The parking brake system is a secondary braking system used to hold a parked car in position. They are applied independently of the service brakes. Since there is no inertia to overcome, less braking power is required to hold the vehicle stationary and less force is required to apply. The application of only two of the four brake assemblies are required to hold the vehicle.

There are three styles of rear parking brake systems. Two types use the service brake and the other is an exclusive parking brake design. The service type parking brake uses part of the ordinary service brake mechanism and operates the shoe or piston mechanically.

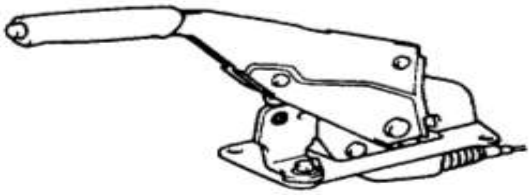
The parking brake lever is located near the driver's seat. Pulling the parking brake lever by hand or pressing the pedal with the foot, operates the brake via a cable connected to the parking brake lever of the brake assembly.

There are a number of different types of parking brake levers, as shown below. Application depends upon the design of the driver's seat and the desired operating effort.

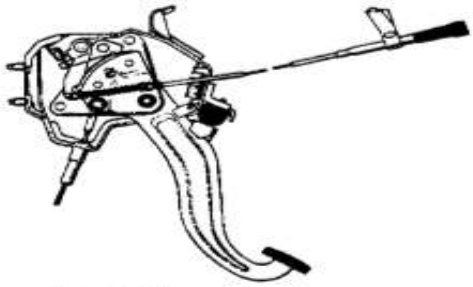
The parking brake lever is provided with a ratchet locking mechanism to maintain the lever at the position to which it was set, until released. Some parking levers have an adjusting screw near the brake lever so the amount of brake lever travel can be easily adjusted. Travel is determined by the number of clicks of the ratchet mechanism found in the Repair Manual.



Stick Type



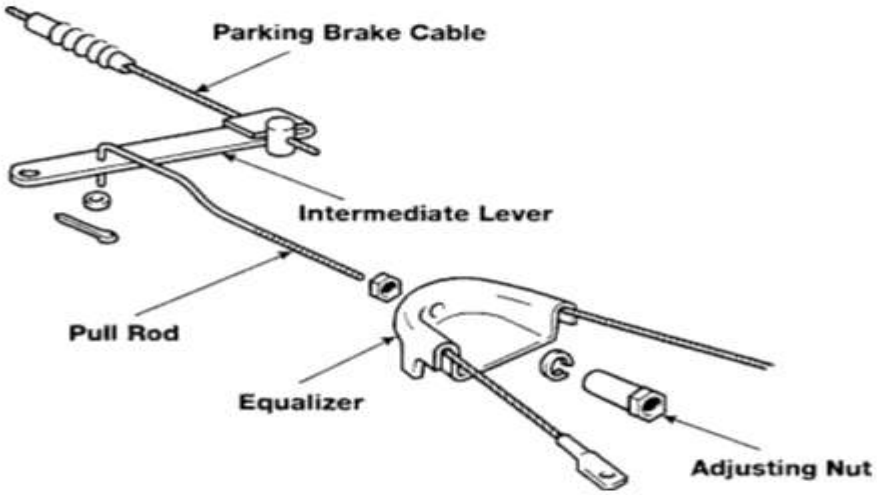
Center Lever Type



Pedal Type

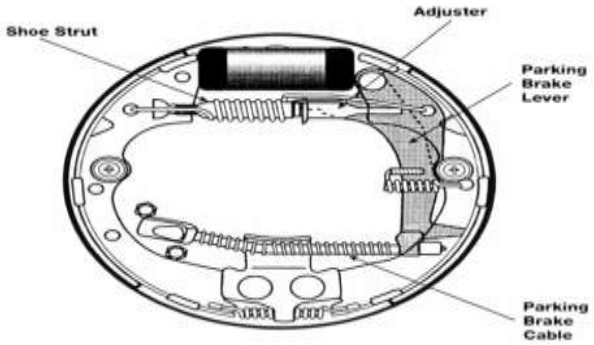
Parking brake linkage

The parking brake cable transmits the lever movement through a typical series of components, as shown below, to the brake drum subassembly. The Intermediate Lever multiplies the operating force to the Equalizer. The Equalizer divides the lever operating force to brake assemblies at both wheels. The two major parts may vary in design however, their function remains the same



Drum parking brake

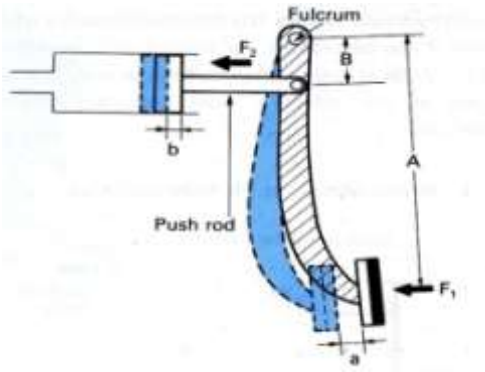
On all models using drum brakes on the rear, the cable pulls the parking brake lever. The lever is attached to the secondary shoe at the top and transfers the lever action to the primary shoe through the shoe strut. When released, the brake shoe springs return the shoes to their retracted position.



Hydraulic service brake

The brake hydraulic system transmit force from the service brake pedal to the brake linings while stopping. In addition to transmitting force the hydraulic system has valves that sense, modify, & limit pressure it also has a warning light to alert the driver to problems in the system. So you must understand the system before doing any brake service work.

The system has a master cylinder, wheel cylinders, & hydraulic valves that either alters, delay, maintain, or compare pressure. Steel brake lines & flexible brake hoses deliver the brake fluid under pressure to the wheel cylinder. The pressure in the system is the same throughout the brake lines regardless of the size or length of the lines. Force is multiplied by using different size pressure areas in the master cylinder & wheel cylinders.

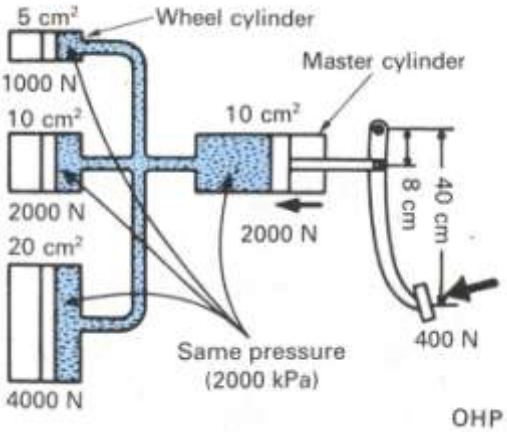


THE MASTER CYLINDER

The master cylinder increases the pressure & moves hydraulic fluid in the brake system. It does thus by changing the mechanical force exerted on the brake pedal to hydraulic pressure. The mechanical advantage produced by linkage at the radial, as shown in Fig. 1 multiplies the effort on the pedal to increase the apply force going to the master cylinder. This mechanical advantages is a ratio 3:1 & 7:1

PASCAL'S LAW

According to Pascal's law, externally applied pressure upon a confined fluid is transmitted uniformly in all directions. Applying this principle to a hydraulic circuit in a brake system, the pressure



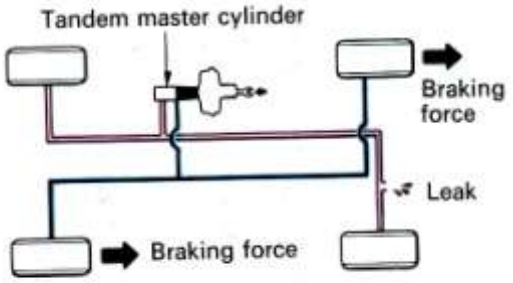
OHP 2

generated in the master cylinder is transmitted equally to all wheel cylinders.
The braking force varies as shown below, depending on the diameter of the wheel cylinders. If a vehicle design requires a larger braking force at the front wheels from example the designer will specify larger cylinders for the front.

TANDEM MASTER CYLINDER

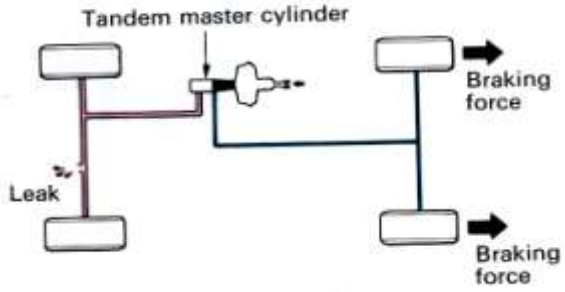
A tandem master cylinder operates a divided or split hydraulic system. It is designed in such a way that if one circuit fails, the other is still operative

② Brake piping in FF type vehicles



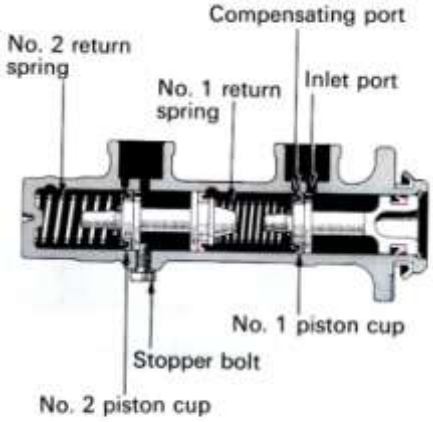
DIAGONAL PIPING

① Brake piping in FR type vehicles



FRONT REAR PIPING

OPERATION



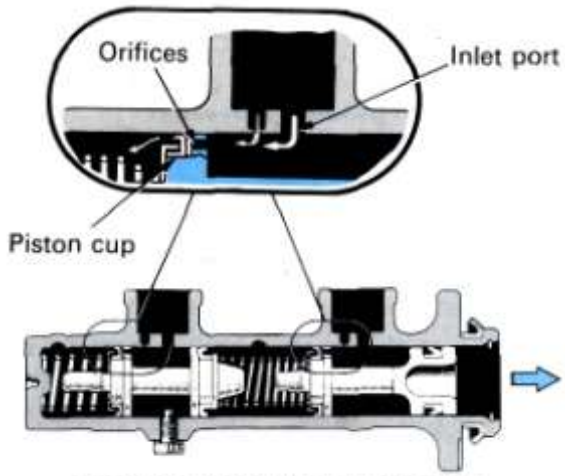
BRAKES NOT APPLIED

1. Which the brakes are not applied the piston caps of No.1 & No2 piston are positioned between the inlet port & the compensating port providing a passage between the cylinder & the reservoir tank.

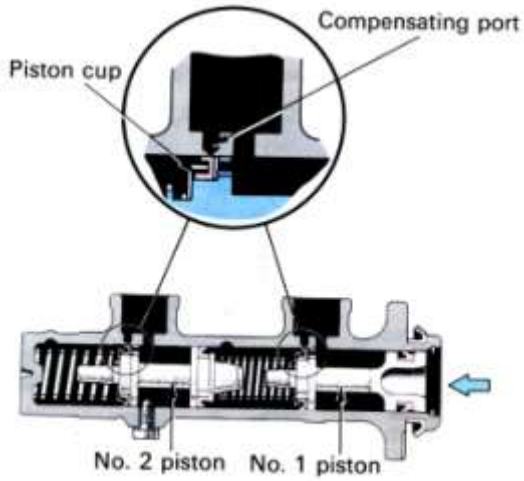
   No.2 piston is pushed to the right by force of No.2 return spring but prevented from going any further by a stopper bolt.

When the brake pedal is depressed No.1 piston moves to the left & the piston cup seals the compensating port to block the passage between the cylinder & the reservoir tank. As the piston is pushed farther, it increases the hydraulic pressure inside the cylinder. This pressure acts on the rear wheel cylinders. This pressure acts on the rear wheel cylinders. Since the same hydraulic pressure also pushes No.2 piston, No. 2 piston operates in exactly the same way as No.1 piston and acts on the front wheel cylinders./

3. When the brake pedal is released the pistons are



BRAKE PEDAL RELEASED (1)



BRAKES APPLIED

returned to their original position by hydraulic pressure & the force of the return springs. However because the brake fluid does not return from the wheel cylinder immediately the hydraulic pressure inside the master cylinder momentarily drops (a vacuum develops) As a result the brake fluid inside the reservoir tank flows in to the cylinder via the inlet port through many or files provided at the tip of the piston & around the periphery of the piston cup.

After the piston has returned to its original position, the brake fluid that gradually returns from the wheel cylinder to the master cylinder flows into the reservoir tank through the compensating parts.

The compensating port also absorbs changes in brake fluid volume that could occur inside the cylinder due to temperature changes. This prevents the hydraulic pressure from rising when the brakes are not being used.

OUTLET CHECK VALVE

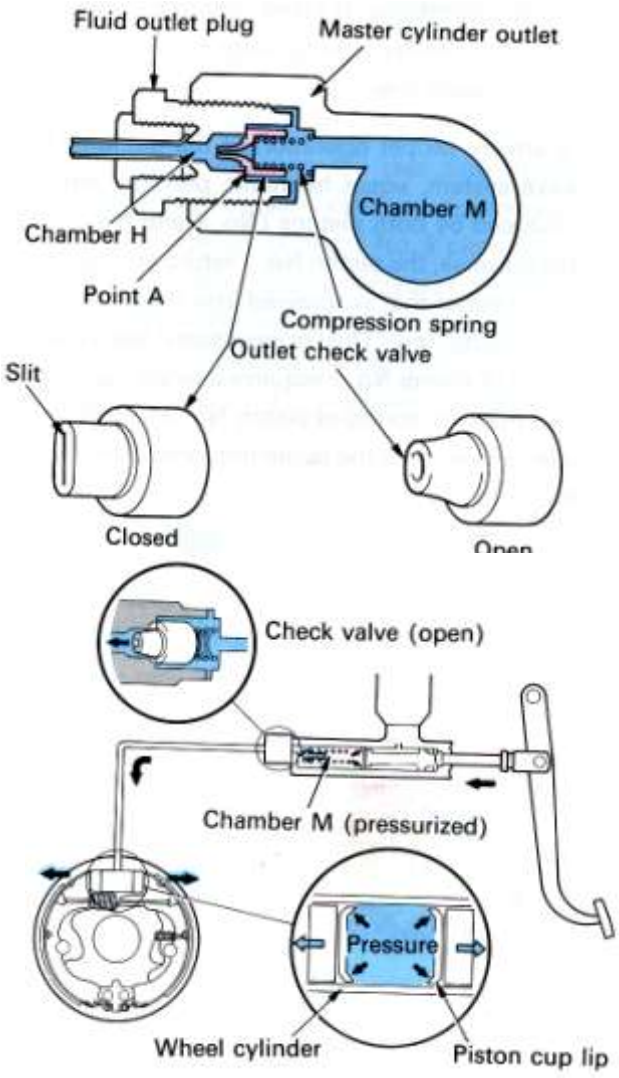
In some types of master cylinders, check valves are installed in the cylinder outlets.

The outlet check valves are designed to allow fluid to flow quickly from the master cylinder to the wheel cylinders but to return slowly from the wheel cylinders back to the master cylinder. This makes air bleeding much easier.

Outlet check valves also allow a small amount of pressure (residual pressure) to remain in the pipe line & wheel cylinders to prevent fluid lackage by keeping the wheel cylinder cups expanded residual pressure is not necessary with the design of seals used in wheel cylinders of disc brakes in fact it is undesirable pressure remaining in the system would prevent the pads from releasing fully and would cause premature pad wear.

An outlet check valve is fitted together with a compression spring between the master cylinder outlet & the fluid outlet plug. Consequently the check valves is pushed to the left by the compression spring & separates chamber H from chamber M at point A check valves are made of rubber & a sharp slit is provided at the end.

The slit remains closed when there in no pressure, but it opens up when pressure is generated. This allows fluid to flow easily from chamber M to chamber H.



Brake failure warning

A brake failure warning switch can be included in a tandem master cylinder A plunger type switch is operated by a spool valve, Normally the switch plunger rests in a groove in the valve & the switch is in the " off " position movement of the valve raises the plungers so that the switch is " on " & this illuminates a warning lamp on the dash.

PROPORTIONING VALVE / P- Valve/

There are the following types of p. valves each designed to prevent early lock up of rear wheels

- P. valve
- P & Bv / Proportioning & By pas valve/
- LSPV / Load sensing proportioning valve/
- DSPV / Declaration sensing proportioning valve/.

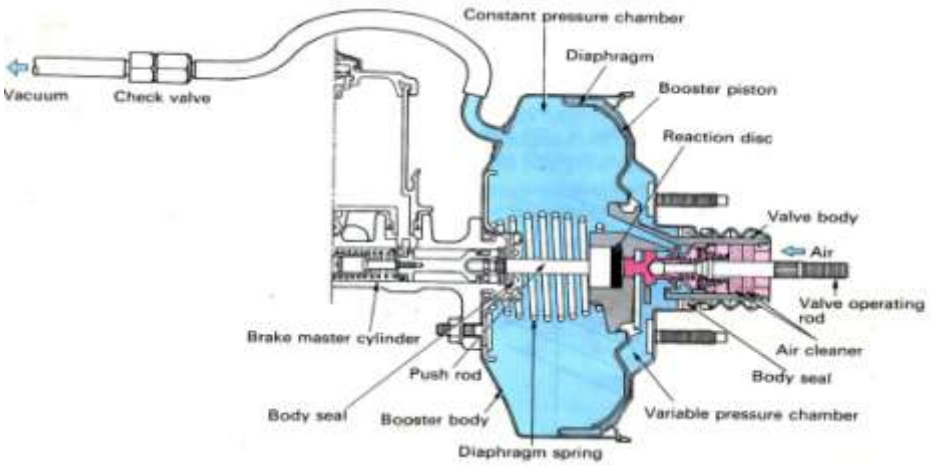
BRAKE BOOSTER

The performance of the brake booster varies depending on the size of the area on which atmospheric pressure & vacuum act. The larger the boosting power normally, a brake booster increases the braking force by 2 to 4 times.

Construction:-

- The inside of the brake booster is open via the check valve to the intake manifold / the vacuum pump on diesel models/ when the engine is started the brake booster is filled with vacuum
- The check valve is designed in such a way that it allows air to flow from the booster to the engine but not the other way therefore it maintains the maximum vacuum created by the engine in the booster.
- The booster is divided by the diaphragm in to two sections the constant pressure chamber and the variable pressure chamber the inner circumference of the diaphragm is fixed to the valve body together with the booster piston. The booster piston & the valve body are pushed to the right by the diaphragm spring.

The valve body contains valve mechanism. Air is allowed to enter from the air cleaner according to the movement of the valve-operating rod, thus regulating pressure in the variable pressure chamber according the push is positioned via a reaction disc, in the left side of the valve body. When the brakes are applied the push rod moves to the left to activate the master cylinder.

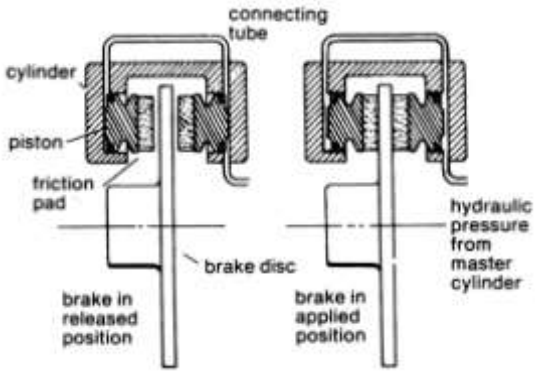


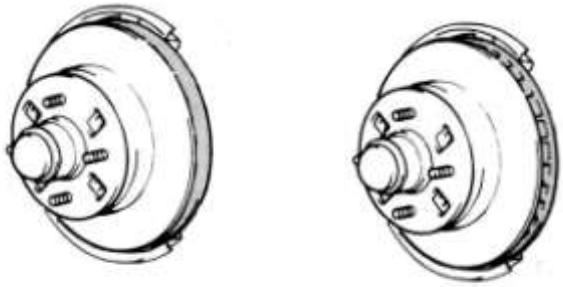
Disc Brakes

Disc brake consists of two main parts: the disc, also called the rotor, and the caliper assembly. The disc rotates with the wheel hub. The caliper, which straddles the disc, is held stationary. In front wheel brakes the caliper is bolted to the steering knuckle, in rear-wheel brakes the caliper is bolted to the axle flange. The caliper assembly includes a hydraulic cylinder, piston & the brake pads.

The diagrams below show the principle of disc brake operation. With the brake in the released position, the pads are slightly clear of the disc, which rotates between them. When the brake is applied, pressure from the master cylinder forces the pistons against the pads, which are then forced against the disc. This produces a clamping action, which slows or stops the disc.

When the brake is released, the pistons retract slightly to allow the pads to move away from the disc. The pads have no return springs, but the pistons are returned slightly in their bores by the resilience of the piston seals. The small run out of the disc (around 0.05) moves the pads away from the disc surface to provide clearance and prevent wear.



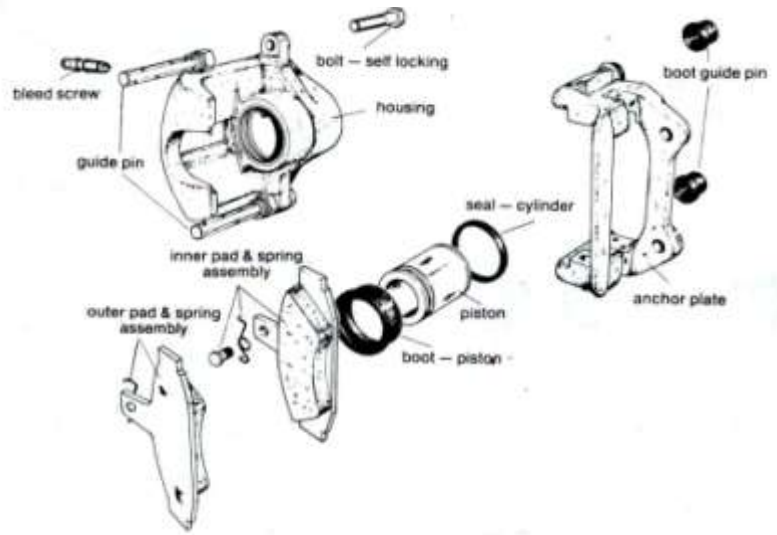


SOLID TYPE VENTILATED TYPE

Components of disc brake

1. Brake disc

Disc is made of cast iron, with a machined surface on each side against which the pads are applied. The disc is usually shaped to fit the wheel hub to which it is bolted. Some brakes use a



ic brake caliper assembly of the sliding caliper type GMH

ventilated disc. This is of hollow construction, consisting of two flanges separated by fins. The rotating disc acts as a form of air pump to maintain a flow of air through the disc and so remove heat generated during braking.

2. Disc brake callipers

The typical disc brake calliper assembly has calliper housing, one or more pistons seal on each piston, adust boot for each piston, and two brake pads.

The disc brake calliper may be fixed, sliding, or floating. The fixed caliper has piston on both sides of the caliper. The force of each piston is applied directly to a brake pad. The sliding and floating caliper designs use one piston, which acts to put apply force on the inside pad. The reaction force of the caliper applies the out-side pad.

3. Disc pads

A disc pad consists of a steel backing plate with friction material bonded to it surface. The pad is positioned by guide lugs that fit into slots in the caliper or in the anchor plates. Antirattle clips are fitted to lugs to prevent the pad from rattling in the slots when the brakes are released. A steel shim is often fitted between the back of the inner pad and the piston.

4. Caliper Pistons

Caliper pistons have the piston seal mounted stationary in the housing and the piston in the seal. This design requires a good piston surfaces finish for maximum seal life. Mounting the seal in this way produces the force to pull the released piston and pad away from the rotor to reduce drag. This design provides "self-adjustment" to automatically maintain the correct lining-to-rotor clearance.

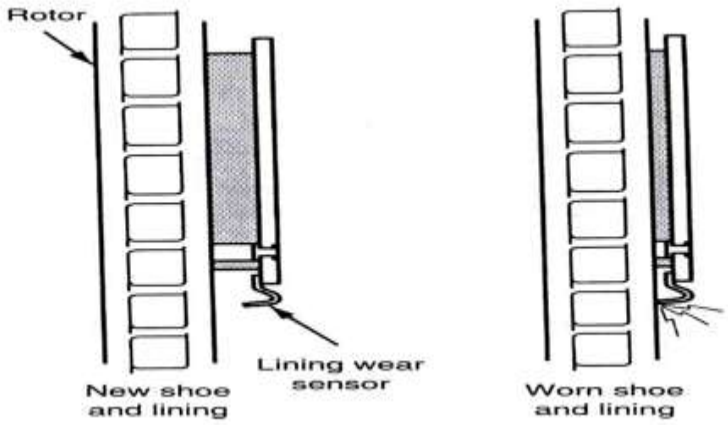
5. Piston Seals

Most sliding and floating calipers have the piston seal mounted stationary in the housing and the piston moves in the seal. This design requires a good piston surface finish for maximum seal life. Mounting the seal in this way produces the force to pull the released piston and pad away from the rotor to reduce drag. This design provides "self-adjustment" to automatically maintain the correct lining-to-rotor clearance.

Some fixed-caliper type has the seal mounted on the piston and the seal slides on the cylinder bore. The cylinder bore in these calipers must have a smooth surface finish for maximum seal life. The seal does not move the piston back into the cylinder on release.

6. Pad Wear Indicator

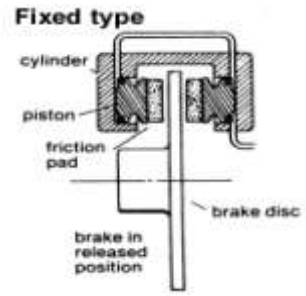
When pad thickness is reduced the pad wear indicator, fixed to the backing plate of the pad, come into contact with the rotor disc and produces a screeching noise during driving.



Types Of Disc Brakes

There are three general types: Fixed-caliper, Sliding-caliper, and Floating-caliper.

1. **Fixed-caliper:**

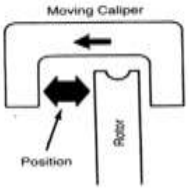


The fixed caliper disc brake has piston on both sides of disc. Some fixed-caliper disc brakes have two pistons, one on each side. Other has four pistons two on each side. The caliper is rigidly attached to the stationary car parts. In operation, the two or four pistons are forced out ward from their caliper bores by hydraulic pressure. This causes the two shoes to move in against the rotating disc.

2. **Floating-Caliper:**

The floating caliper, or swinging caliper can pivoted, or swinging in or out It is suspended from rubber bushings on - 19 - Created by Automotive Department bolts, Which give enough to permit. The caliper has either one or two piston.

In operation, hydraulic pressure from back of the piston forces the brake pad on the piston side against the rotating disc. This produces a reaction force against the caliper that causes the caliper to move inward slightly, so other side of the rotating disc. Now, braking action is the same as with the fixed-caliper type.



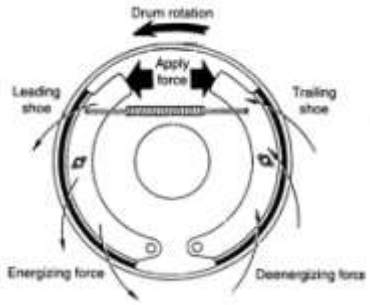
3. **Sliding-caliper:**

The principle of operation of a sliding caliper is the same as that of a floating caliper. The difference is in the method - 19 - Created by Automotive Department of attaching the caliper to the mounting bracket. The grooves (or the sliding surfaces) in the caliper and mounting bracket are called ways. The caliper is held in the ways by a retaining key, a spring, and a lock screw. There is no sideward motion of the caliper when the brakes are applied.

The mounting bracket is bolted to the steering knuckle. The brake pads are held in the bracket whit two retaining pins. The cylinder housing is attached to the yoke, and the yoke is free to slide on the mounting bracket. When the brakes are applied, hydraulic pressure pushes against the piston in the cylinder housing. The piston pushes the inner brake pad against the inner sides of the rotor.hydraulic pressure also pushes the cylinder housing inward to the center of the car. Because the yoke is attached to the cylinder housing, the yoke moves with the housing. This pushes the outer brake pad against the other side of the rotor.

Types of drum brake

Generally, there are three types of drum brake, 1. leading trailing shoe drum brake, 2. two leading shoe drum brake, 3. duo servo drum brake.

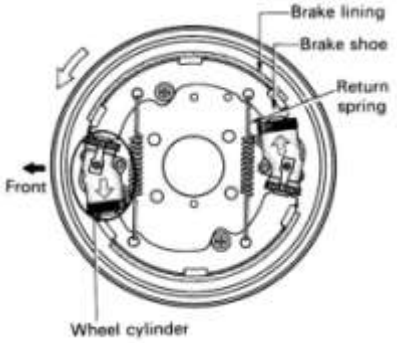


1. **Leading trailing shoe drum brake**

In this type, the forward shoe is held stationary at the bottom and pushed against the drum by the wheel cylinder at the top. As the drum rotates, this leading shoe is pulled tighter into the drum and tends to rotate with the drum. But because the shoe is anchored at the bottom, the shoe simply wedges itself into the drum. As a result, the leading shoe does most of the breaking due to self-energizing action of the

leading shoe.

When the rear or trailing shoe contacts the drum, drum rotation tries to force the shoe away from the drum. There is no self-energizing action. Therefore, the trailing shoe usually wears less than the leading shoe.

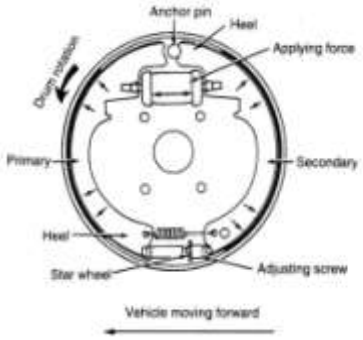


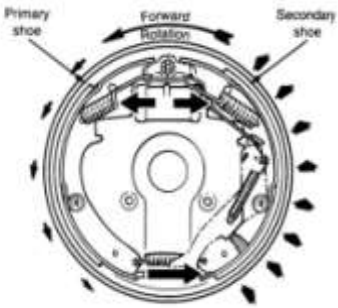
2. Two leading shoe drum brake

This system is arranged with two single-acting wheel cylinder instead of a one double-acting cylinder as leading trailing and duo servo types. The effect of this is to produce a wedging action in both the front and rear shoes. Each cylinder forces one end of its shoe outwards and a self-energizing effect is imported to each shoe due to drum rotation. Thus both shoes provide equal breaking with a force greater than that, which could be applied by normal means.

3. Duo servo drum brake

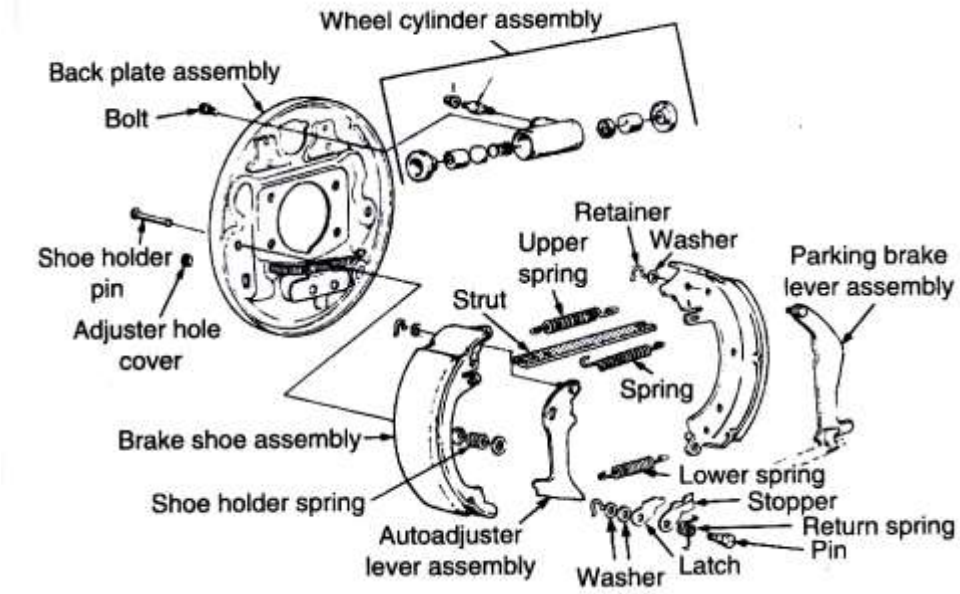
The tops of the shoes rest against a single anchor pin. The bottoms of the shoes are linked together by a floating adjusting screw. The shoe towards the front of the vehicle is the **primary shoe**. The shoe toward the rear is the **secondary shoe**. The primary shoe normally has shorter lining than the secondary shoe.





When the shoes contact the rotating drum, the friction causes both shoes to try to rotate with the drum. The top of the primary shoe tends to pull into the drum and move downward. The bottom of the shoe then pushes the adjusting screws rearward. This forces the bottom of the secondary shoe against the drum that moves the secondary shoe upward against the anchor pin. Further drum rotation tends to pull both shoes more tightly into the drum. This further increases the self-energizing action of the secondary shoe.

Component of drum brake



1 Brake drum

It is rotates with he wheel of the vehicle and provides a braking surface against which the brake linings operate .The brake shoes are expanded inside the drum and so the drum must be capable of withstanding the force applied by the brake shoes without distorting .The brake drum must be capable of absorbing the heat produced by friction between the shoes to prevent excessively high temperatures developing in the brake assembly

Cast iron is the used for braking drum because it has the necessary properties which make it suitable for this purpose.

Backing plate

The backing plate for the front brake is mounted to the steering knuckle and the backing plate for the rear brake is mounted to the axel flange. The backing plate carries all the stationary brake parts, which include the wheel cylinders, brakes shoes, return springs, retaining spring, anchor and adjuster .It is not only acts as a support for the brake shoes and associated parts, but also acts as a shield to exclude road dirt.

The backing plate is steel pressing which has its outer edge flanged to over the edge of the drum.

Brake linings

The brake shoes are shaped to fit the contour of the brake drum with which they are used .A shoe consists of the web and the flange .The web is provided to stiffen the flange. The flange is fitted with a lining of friction material, which is either riveted or bonded to it.

Most passenger cars and light commercial vehicles have bonded brake linings.

Brake springs

Springs are fitted to the brake shoes to locate the shoes on the backing plate. The return springs oppose the action of the brake shoes when the brakes are applied and return the shoes to their normal position when the brakes are released.

Retaining springs and clips are used to hold the brake shoes against the backing plate. Other springs are used to locate the shoes in position or to hold the ends of the return springs.

Anchors

Anchors are used to locate the ends of the shoes by providing an abutment against which the shoes can rest. Anchor pins are used to hold the ends of the return springs.

Adjusters

Various types of adjusters are used to adjust the working clearance between the brake shoes and the drum.

Wheel cylinders

The wheel cylinder is bolted to the backing plate. It forms an anchor for one end of the shoe and expands the shoes when the brakes are applied.

Operation of the drum brakes

- **Brakes not applied**

Pistons inside the wheel cylinder are constantly pushed backward, via brake shoes, by the return spring. They are pushed back to the strut touches the shoes.

The compression spring in the wheel cylinder is fitted so that piston and shoes will contact each other at all time. This prevents unusual noise from the brakes.

- **Brakes applied**

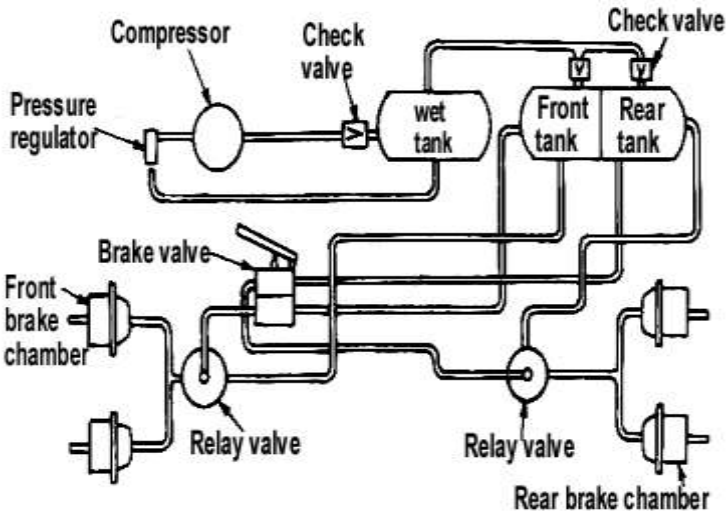
When the brake pedal is depressed, hydraulic presser inside the master cylinders, forces shoes apart so that they rub against the lining and stop the wheel rotation. The hydraulic pressure in the wheel cylinder also acts on the lips of the piston cup. It pushes the lips against the cylinder and prevents from leaking.

Pneumatic service brake

Basic principle of air brake

Air brake uses air pressure to move brake shoe. It can get large brake force with small pedaling force. Therefore, this types brake is used in large types of vehicles.

The whole structure is like the above diagram. Front & rear systems work separately. In the case of there is leakage in one system, the other system works for safety.



Air compressor

Engine drives this. It makes compressed air. To regulate the air pressure in the tank, un-loader valve is attached on the suction valve.

Air tank

There are 3 kinds of tanks, wet tank, front tank and rear tank. Wet tank is to remove moisture from compressed air. Front and rear tank accumulate the compressed air for each front and rear system.

Brake valve

The brake pedal operates this valve. It sends compressed air to relay valve according to the depressing condition of the pedal. To control the front and the rear system simultaneously, there are two valves inside of it.

Relay valve

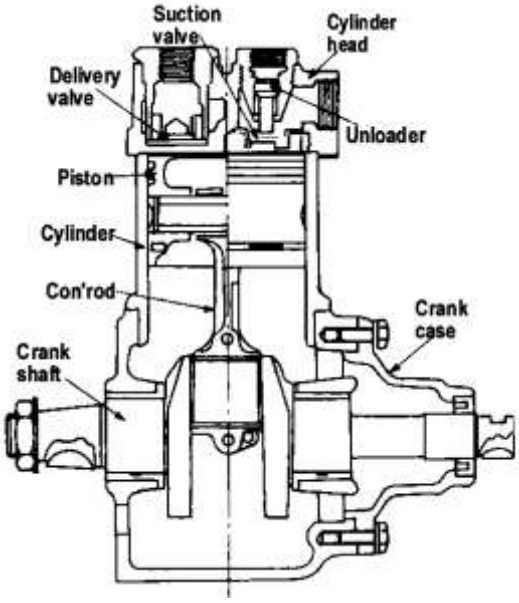
Each of the front and the rear system has this valve. It works according to the compressed air from brake valve and controls the compressed air from the tank to the brake chamber. When the brake pedal is released, the compressed air in the brake chambers is exhausted from this valve.

Brake chamber

It receives the compressed air from relay valve and makes to rotate the brake cam in the drum brake.

Pressure regulator

It regulates the compressed air in the tanks. When the pressure reaches the regular, it sends air to the un-loader valve in the air compressor. The un-loader valve makes to open the suction valve to stop the compression.



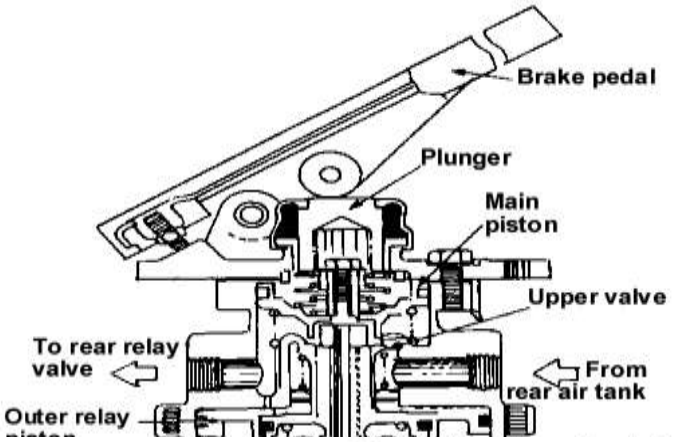
Air compressor

Engine drives air compressor. In the cylinder head, there are plate type suction valve and delivery valve. On the suction valve, the un-loader valve is attached.

When the air pressure in tank becomes high, by means of the compressed air from the pressure regulator, the un-loader valve opens the suction valve. The suction valve inhale the air, therefore there is no air compression. When the air pressure becomes low, the compressed air from the pressure regulator is exhausted and the un-loader valve is returned by spring force, therefore the air compressor start to compress the air again.

■ **Brake valve**

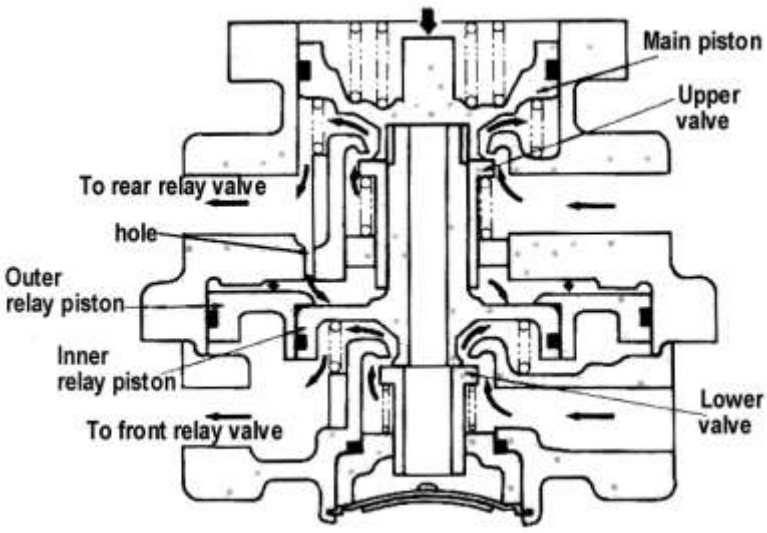
As brake valve, treadle type is common. In this type, brake pedal and valve is directly connected. The brake pedal pushes down valve via plunger. The body is apart into the upper part and lower part. The upper part supplies compressed air to the front system, the lower part supplies air to the rear system. Each line has intake and exhaust valve.



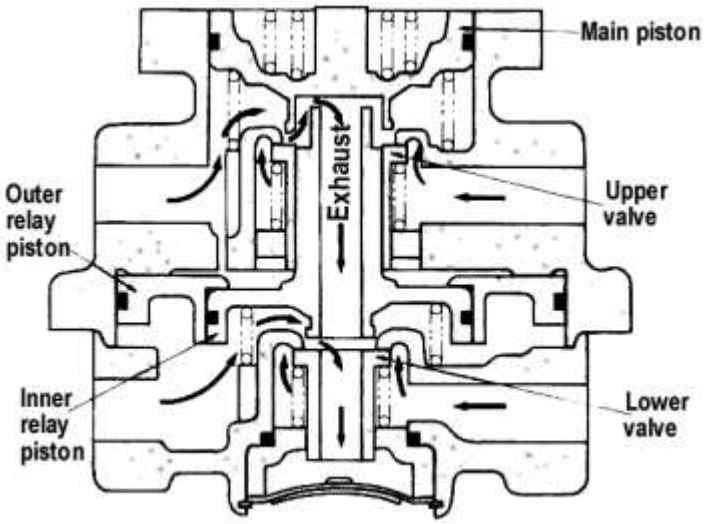
Operation

During the brake pedal is released, main piston and relay pistons are returned by the springs and air pressure, therefore the way to the relay valve is closed.

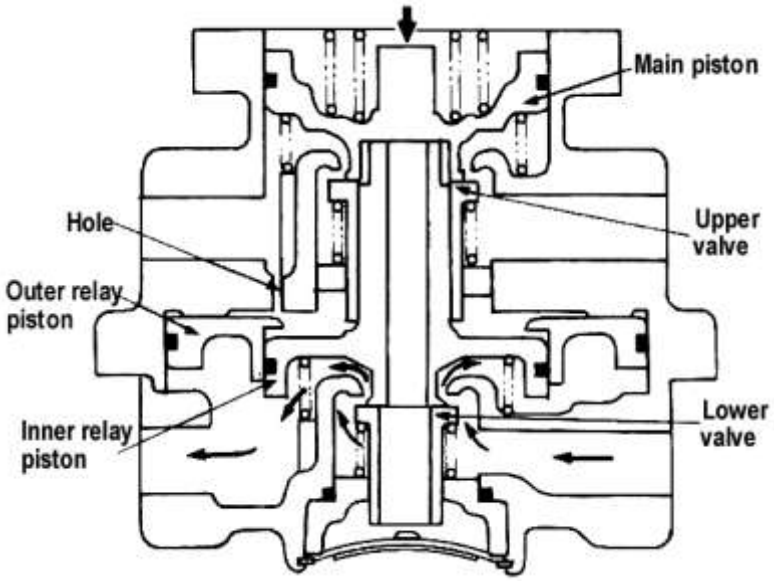
When the pedal is depressed, the plunger is pushed down. The plunger



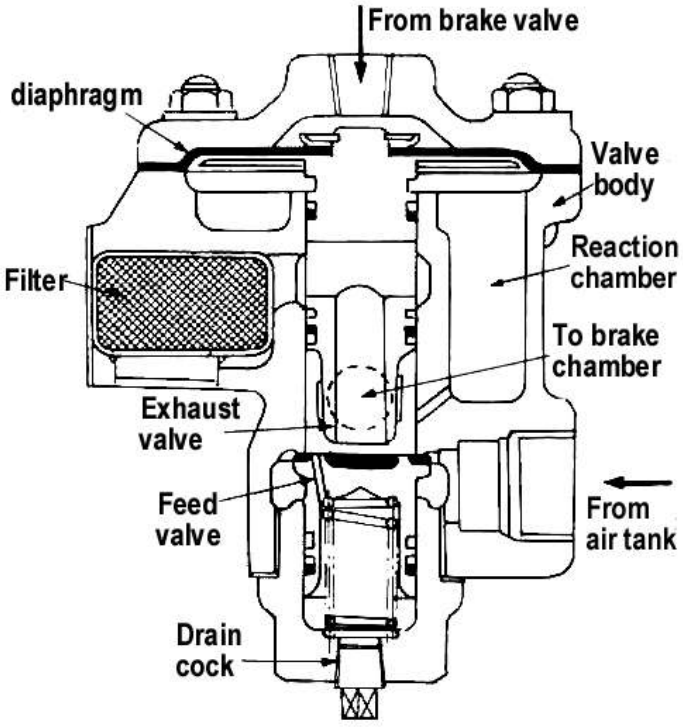
pushes down the main piston via main spring. The main piston compresses the return spring and closes the exhaust of the upper valve. At the same time, the intake of the upper valve is opened. As a result, the compressed air from rear air tank passes through the upper valve to the rear relay valve. Simultaneously, this compressed air passes through the "hole" (see the above diagram) and pushes down the relay pistons. Then the exhaust of the lower valve is closed and the intake is opened. Like this, the valve for front relay valve is opened by the compressed air for rear relay valve. As the compressed air to the relay valves become high, the air pressure pushes up the main piston. When the pressure force and the main spring force are balanced, the upper and lower valves are closed. That means, in proportion to the pedal depressing condition, the compressed air is sent to the relay valves. When the pedal is released, the main piston is returned up by the return spring. The intake of the upper valve is closed and the exhaust is opened. The air for rear is released. For the lower valve, the compressed air on the upper side of the relay pistons is also gone, therefore the relay pistons are returned up and the intake of the lower valve is closed and the exhaust is opened.



If there is leakage on the rear (upper) system, there is no air pressure on the relay pistons, but the main piston pushes down the inner relay piston directly. Therefore the front (lower) system is operated mechanically. In the case of there is leakage on the front (lower) system, the operation is same as the normal, but there is no compressed air for the front (lower) system, just the lower valve is opened.



- **Relay valve**

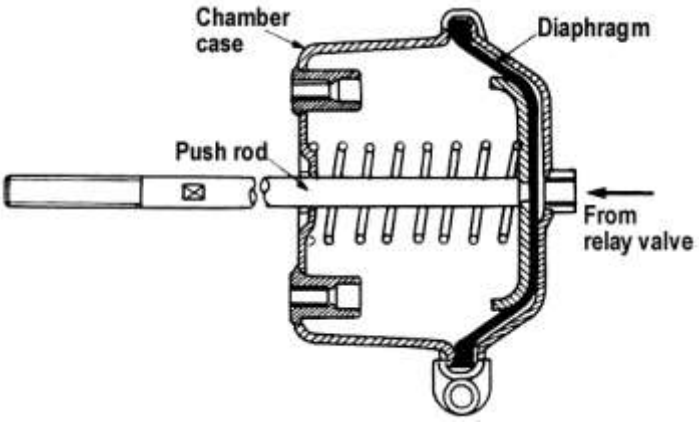


The relay valve is operated by the compressed air from the brake valve. It opens or closes the airline from the tank to the brake chamber, and prevents the operational delay on the brake. Each of the front and rear system has it.
The air from brake valve reaches on the upper side of the diaphragm. The diaphragm with the exhaust valve is pushed down and the exhaust is closed. At the same time, feed valve is opened and the air from the tank passes through the feed valve to the brake chamber. The pressure on the brake chamber makes effect to the lower side of the diaphragm. When the upper side pressure from the brake valve and the pressure from the lower side from brake chamber are balanced, the feed valve pushes up the diaphragm via the exhaust valve. That means, the same pressure from brake valve acts to the brake chamber.
When the pedal is released, the pressure on the upper side of the diaphragm is exhausted from the brake valve. By means of the pressure in the reaction chamber, the diaphragm is pushed up, the feed valve is closed by the return spring, and then the exhaust valve is opened. The compressed air in the brake chamber is exhausted passes through the filter.

Brake chamber, wheel brake

The brake chamber makes breaking force by means of the air pressure from the relay valve. When the compressed air from the relay valve flows into the chamber case, the diaphragm presses the pushrod. The push rod turns the brake cam via slack adjuster and the brake shoes are pressed to the brake drum. For the wheel brake, leading-trailing shoe type is common.

The slack adjuster has worm shaft and worm gear inside of it. By the rotation of the worm shaft, adjust the position of the worm gear with brake cam, to adjust the clearance between the lining and the drum.



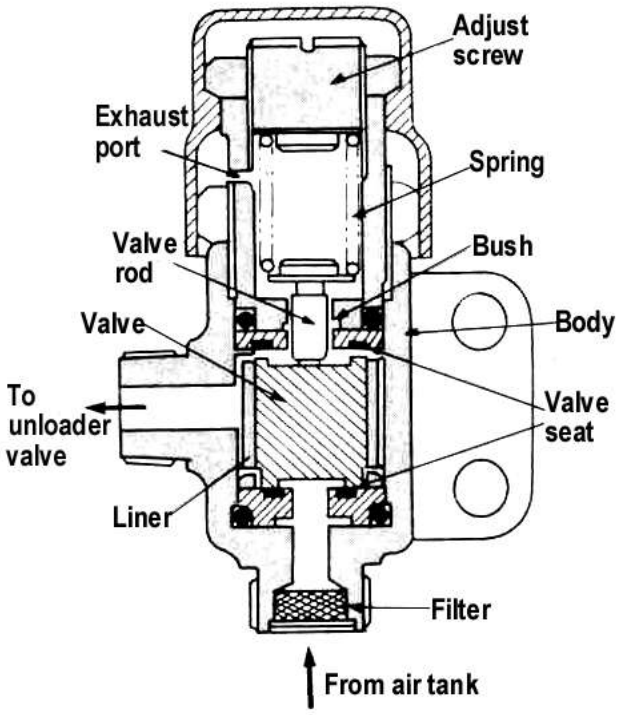
■ **PressPressure regulator**

The pressure regulator adjusts the pressure in the tanks. It works according to the air pressure in the tank.

When the air pressure is lower than the regulation, the spring pushes the valve to the lower valve seat. The passage from air tank to the un-loader valve is closed.

When the air pressure reaches the regulation, the compressed air pushes up the valve, the lower valve is opened, and the upper valve seat is closed. The compressed air passes through to the un-loader valve. As a result, the compressor stops to compress the air.

After that, the air pressure becomes lower than regulation again. The spring force presses the valve to the lower direction. The passage from the air tank to the un-loader valve is closed again. The un-loader valve side compressed air is exhausted from the upper side of the valve.



Combined service brake

It is necessary to change the driver of vehicles with ICE to either hybrid or electric motor. It allows one to extend not only lifespan of the already-existing vehicle, but also to develop transport infrastructure.

The fuel and maintenance costs are the most important factors for commercial transportation. Under highly competitive conditions, it is rational to use additional equipment, which reduces transportation expenses. One of these is a retarder. It is equipment, which is needed for significant safety improvement, reliability growth and efficiency upgrading of the brake system in the long-sustained load. Generally, it is used in case of heavy-duty trucks or buses driving along the mountain road. Also the retarder can be applied for urban buses, which work in the cycle mode with excessive fuel consumption.

There are some retarder advantages:

- fine dust emissions reduction, absence of oil or another liquids;
- lifespan extension along with the reduction of the maintenance costs;
- braking system does not run hot in case of extended braking;
- there is a possibility of recuperation energy use.

Thus, the main objective of this research is to simulate the energy recuperation process of the brake system for the vehicle with internal combustion engine. In this regard, the tasks are following:

- to carry out an analysis of the existing retarders;
- to compare characteristics and possibility of using retarder systems for the recuperation;
- to develop the calculation methodology for retarder's major elements for various vehicle types.

The main part

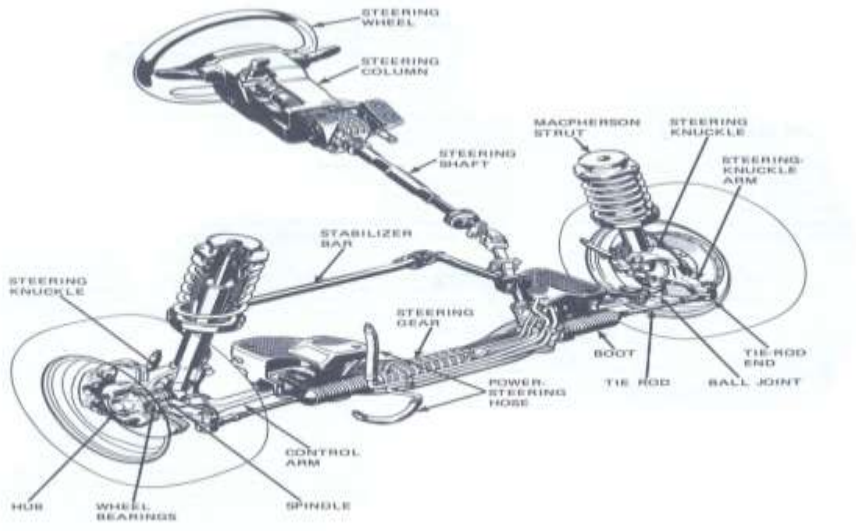
For vehicle braking, the following systems are used:

- **service brake,** which is a device for arresting or preventing the motion of a vehicle usually by means of friction;
- **motor braking**, which is carried out by fuel delivery decrease and cessation by downshifting a gear;
- **exhaust retarder** (different devices for vehicle braking onto the long slope);
- **retarder brake** (retarder) – equipment for vehicle's speed reduction without the service brake use.

There are electro dynamic retarders (eddy-currents or with permanent magnets) and hydrodynamic (intarders), which use for operation either automatic transmission oil or ICE coolant.

1.1.3. Steering system

The steering system allows the driver to control the direction of vehicle travel. This is made possible by linkage that connects the steering wheel to the steerable wheels and tires. The steering system may be either manual or power. When the only energy source for the steering system is the force the driver applies to the steering wheel, the vehicle has manual steering. Power steering uses a hydraulic pump or electric motor to assist the driver's effort. Most vehicles have power steering to make parking easier. The basic operation is the same for both manual and power steering. As the driver turns the steering wheel, the movement is carried to the steering gear. It changes the rotary motion of the steering wheel into straight line or linear motion. The linear motion acts through steering linkage or tie rods attached to the steering-knuckle. The steering knuckles then pivot inward or outward on ball joints.



- Driving dynamics
  - ✓ **Centre of gravity**

In the method for steering the rear wheels, the slip angle at the vehicles center of gravity is maintained at zero, which improves the basic dynamic properties of the vehicle.

- ✓ **Movement**

The steering system converts the rotation of the steering wheel into a swivelling movement of the road wheels in such a way that the steering wheel rim turns a long way to move the road wheels a short way.

- ✓ **Slip angle**

The angle through which the wheel has to sustain the side force is called slip angle or creep angle. The angle between direction of the motion of the vehicle and the center plane of the tyre. It ranges from 8^0 to 10^0

- ✓ **Overseers or under steer**

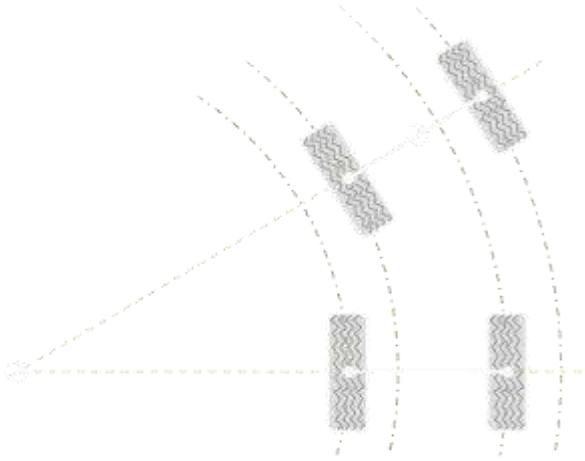
Oversteer occurs when the rear of the vehicle tends to swing outward more than the front during cornering. This is because the slip angle on the rear axle is significantly greater than the front axle. This causes the vehicle to travel in a tighter circle, hence the term oversteer. If the steering angle is not reduced the vehicle will break away and all control will be lost. Turning the steering towards the opposite lock will reduce the front slip angle.

Understeer occurs when the front of the vehicle tends to swing outward more than the rear during cornering. This is because the slip angle on the rear axle is significantly smaller than the front axle. This causes the vehicle to travel in a greater circle, hence the term understeer. If the steering angle is not increased the vehicle will be carried out of the corner and all control will be lost. Turning the steering further into the bend will increase the front slip angle. Front engined vehicles tend to understeer because the centre of gravity is situated in front of the vehicle centre. The outward centrifugal force therefore has a greater effect on the front wheels than on the rear.

1.1.4. Principle of steering

Turntable steering

This first kind of simple steering is often called “Turntable Steering”. There’s a single pivot in the center of the front axle. Both the front and rear axles are solid.



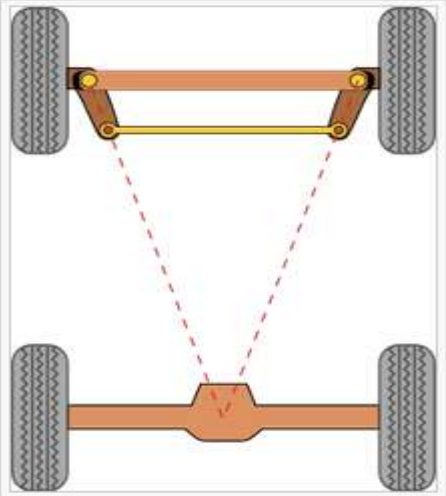
By rotating the front axle, the geometry is adjusted so that both axles are pointing towards a common point. Each wheel travels around in a circle with a common center (albeit it with different radii), removing the need for side-slip or skidding. In a simple carriage, each wheel is independently free-wheeling, and the traction force is not provided by the wheels, so the differences in the circumferences is compensated by each wheel having a slightly different rotation rate. If the vehicle were travelling over a muddy field, you might see four circular arcs as it turned.

This is an elegant solution for maneuverability, but it has quite a few problems: The axle has to swing through large arcs to make turns, and this reduces the usable space inside the wheelbase (or requires the occupied space to be high above both axles). It’s a single stress point, making the addition of suspension challenging, and the long axle acts like a lever amplifying small variations in road surface.

Ackermann steering

A simple approximation to perfect Ackermann steering geometry may be generated by moving the steering pivot points inward so as to lie on a line drawn between the steering kingpins and the centre of the rear axle. The steering pivot points are joined by a rigid bar called the tie rod which can also be part of the steering mechanism, in the form of a rack and pinion for instance. With perfect Ackermann, at any angle of steering, the centre point of all of the circles traced by all wheels will lie at a common point. Note that this may be difficult to arrange in practice with simple linkages, and designers are advised to draw or analyse their steering systems over the full range of steering angles.

Modern cars do not use *pure* Ackermann steering, partly because it ignores important dynamic and compliant effects, but the principle is sound for low-speed maneuvers. Some racing cars use *reverse* Ackermann geometry to compensate for the large difference in slip angle between the inner and outer front tyres while cornering at high speed. The use of such geometry helps reduce tyre temperatures during high-speed cornering but compromises performance in low-speed maneuvers.



Simple approximation for designing Ackermann geometry

1.1.5. Steering gear

- **Mechanical**

The purpose of the steering gear is to change the rotational motion of the steering wheel to a reciprocating motion to move the steering linkage. There are three styles currently in use: the recirculating ball, worm and roller, and the rack and pinion. The latter gear assembly incorporates the already described rack and pinion linkage system and steering gear as a single unit.

A sector shaft is supported by needle bearings in the housing and a bushing in the sector cover. A ball nut is used that has threads that mate to the threads of the worm shaft via continuous rows or ball bearings between the two. Ball bearings recirculate through two outside loops, referred to as ball return guide tubes. The ball nut has gear teeth cut on one face that mesh with gear teeth on the sector shaft. As the steering wheel is rotated, the worm shaft rotates, causing the ball nut to move up or down the worm shaft. Since the gear teeth on the ball nut are meshed with the gear teeth on the sector shaft, the movement of the nut causes the sector shaft to rotate and swing the pitman arm.

The design of two separate circuits of balls results in an almost friction-free operation of the ball nut and the worm shaft. When the steering wheel is turned, the ball bearings roll in the ball thread grooves of the worm shaft and ball nut. When the ball bearings reach the end of their respective circuit, they enter the guide tubes and are returned to the other end of the circuits. The teeth on the sector shaft and the ball nut are designed so that an interference fit exists between the two when the front wheels are straight ahead. This interference fit eliminates gear tooth lash for a positive feel when driving straight ahead. Proper mesh engagement between the sector and ball nut is obtained by an adjusting screw that moves the sector shaft axially.

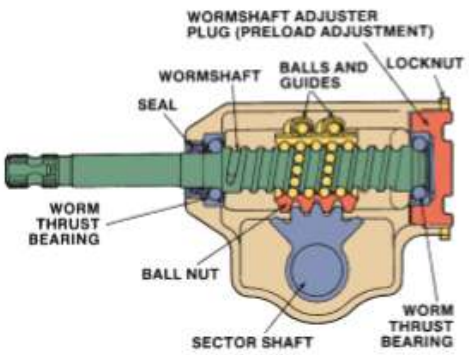
The worm thrust bearing adjuster can be turned to provide proper preloading of the worm thrust bearings. Worm bearing preload eliminates worm end play and is necessary to prevent steering free play and vehicle wander.

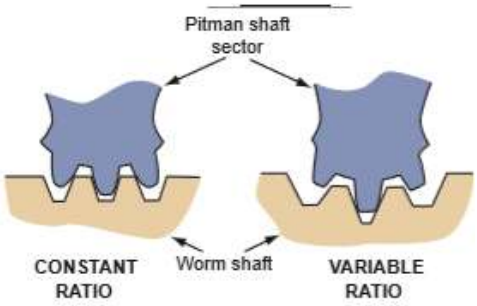
Variable Steering The number of input turns per output turn of the steering gearbox is called the gearbox ratio. Steering gears can have a constant or a variable ratio. The sector teeth in a constant ratio unit are identical in size and shape, while the sector of a variable ratio unit has larger center teeth. This makes the steering faster in turns than in a straight direction. Variable ratio is normally used only in power-steering units.

Worm and Roller The worm and roller gearbox is similar to the recirculating ball except a single roller replaces the balls and ball nut. This reduces internal friction, making it ideal for smaller cars. The steering linkage used with a worm and roller gearbox typically includes a pitman arm, center link, idler arm, and two tie-rod assemblies. The function of these components is the same as in the parallelogram steering linkage described earlier in this chapter. In operation, the steering shaft rotates the worm gear. It, in turn, engages the roller, causing the roller shaft to turn. The shaft moves the pitman arm left or right to steer the vehicle. It must be noted that the steering gear does not cause the vehicle to pull to one side, nor does it cause road wheel shimmy.

Steering Wheel and Column The purpose of the steering wheel and column is to produce the necessary force to turn the steering gear. The exact type of steering wheel and column depends on the year and the car manufacturer. The steering column, also called a steering shaft, relays the movement of the steering wheel to the steering gear.

The steering wheel is used to produce the turning effort. The lower and upper covers conceal parts. The universal joints rotate at angles. Support brackets are used to hold the steering column in place. Assorted screws, nuts, bolt pins, and seals are used to make the steering wheel and column perform correctly. Since 1968, all steering columns have a collapsible feature that allows the column to fold into itself on impact. This feature prevents injury to the driver. In most vehicles equipped with a driver's side air bag, the air bag assembly is contained in the center portion of the steering wheel. This assembly must be disarmed and removed before the steering wheel can be removed.

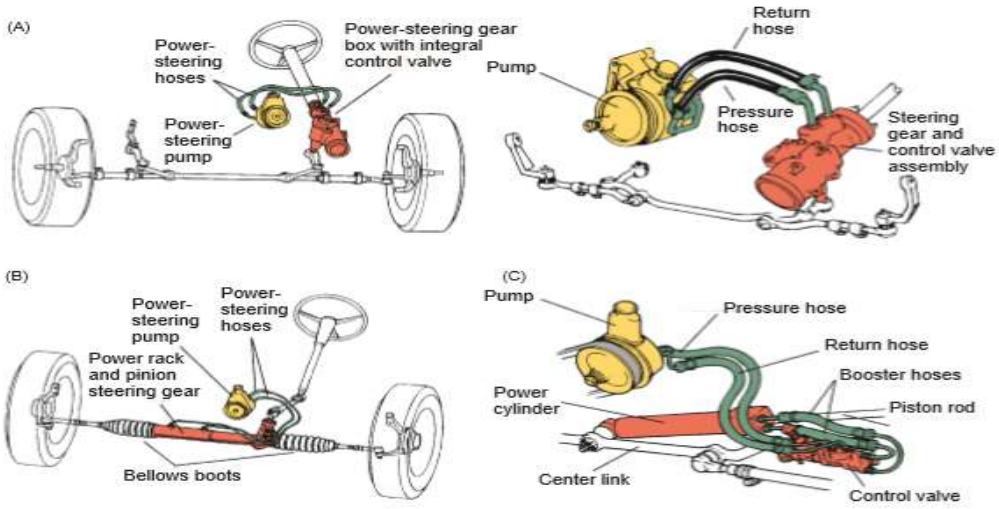




- **Hydraulic and electric**

The power-steering unit is designed to reduce the amount of effort required to turn the steering wheel. It also reduces driver fatigue on long drives and makes it easier to steer the vehicle at slow road speeds, particularly during parking. Power steering can be broken down into two

design arrangements: conventional and nonconventional or electronically controlled. In the conventional arrangement, hydraulic power is used to assist the driver. In the nonconventional arrangement, an electric motor and electronic controls provide power assistance in steering. There are several power-steering systems in use on passenger cars and light-duty trucks. The most common ones are the integral-piston, and power assisted rack and pinion system.

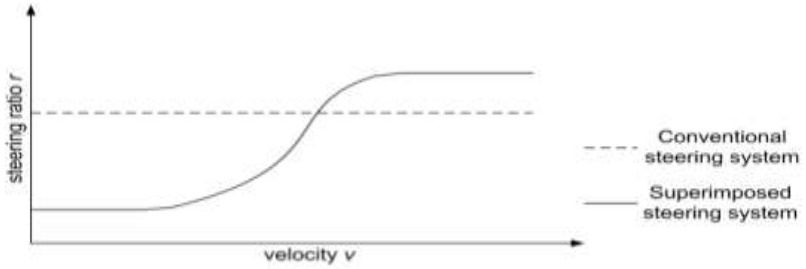


1.1.6. Superimposed steering system

The major advantages of a superimposed steering system over a conventional steering system can be broken down into three main categories.

1. **Variable Steering Ratio**

The steering ratio is defined as the quotient of the angle that the driver imposes on the steering wheel over the actual angle of the wheels on the road. In a conventional steering system this ratio is fixed. However, this is not the best possible solution. At low speeds one would rather want a more direct response of the wheels to the driver's commands, i.e., a lower steering ratio. The vehicle would thus become more agile and parking could be greatly facilitated. At high speeds, one would want the steering transmission to be less direct, i.e., higher steering ratio. This would result in greater vehicle stability due to the compensation for the physically induced increase in steering sensitivity. All this can be achieved using a superimposed steering system. A variable steering ratio is implemented by adding a positive steering angle at low speed and a negative steering angle at high speed. In this thesis we focus on bringing about this first and most important



2. Compensation of Lateral Wind Forces

Lateral wind forces affect the vehicle handling and represent a major risk, especially when passing other vehicles at high velocity. Using superimposed steering, one can automatically compensate for lateral wind forces. A yaw rate sensor detects the lateral acceleration and the superimposed steering system compensates without the driver even noticing.

3. Reduction of Braking Distance in Combination with ESP

Traditional electronic stability programs (ESP) maintain the stability of the vehicle through multiple braking and release cycles of the wheels. The result is a tradeoff between stability and braking distance. This is particularly critical if the vehicle drives on two surfaces with highly different friction coefficients, e.g., asphalt and ice. The vehicle will invariably turn towards one side. Stability can only be regained by releasing the brakes thus increasing braking distance. Combining ESP with superimposed steering, the vehicle will automatically steer so as to compensate for the turning of the vehicle. As a result more power can be applied to the brakes and braking distance can be reduced.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List the types of disk brake; (3 point)
2. List the types of drum brake: (3point)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-02	Identify nature and scope of work

Identify nature and scope of work

The division of work to be performed under a contract or subcontract in the completion of a project, typically broken out into specific tasks with deadlines.

You will need to break down your full scope of work and figure out what the best way to proceed in.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1, Why figure out your scope of work?(10 point)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-03	WHS requirement

Occupational Health & Safety Objectives:
• To secure the health, safety and welfare of persons at work
• To protect the persons at the workplace, against the hazards ascending out of the activities.
• To promote an occupational environment for individuals at work, with concern to the physiological and psychological needs.

Types of Hazards in the workplace:

■ Unsafe Act
■ Unsafe Conditions

Accidents are not always caused by a person hurting himself. But rather, an accident are caused by a person failing to act safely or to correct an unsafe condition.

Some typical examples relating to unsafe acts

- Using equipment without receiving training in its use.
- Using tools and equipment the wrong way
- Fails to use personal protective equipment
- Fooling around or playing practical jokes during work.
- Hurrying and taking dangerous workshops short cuts through the workshop.
- Distracting others from work or allowing yourself to be distracted.

Here are some examples of unsafe conditions

- Lack of instruction in safe workplace methods
- Lack of training
- Unsuitable clothing for the task
- Poor lighting, excessive noise
- Lack of safeguards on machines or engines

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List the types of hazards in the workplace:(10 point)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-04	Source procedures and information

Source procedures and information

The procedure for entering remedy effectiveness into the model was simplified by the Task Force. All of the model entries that would likely be modified by remedies were grouped into 16 "consumer problem areas." It was required only that an estimate of a remedy's effectiveness against each of those areas be specified. The 16 problem areas are:

1. Failure to perform needed preventive maintenance
2. Unnecessary replacement of a component, when it is more economical to wait until it fails
3. Failure to detect faults before they become critical
4. Too much time between maintenance work
5. Superfluous maintenance
6. Inadequate diagnosis of the problem
7. Attempts to sell unneeded repairs with possible fraudulent intent
8. Failure to detect possible intended fraud before repairs
9. Failure to detect possible fraud after repairs
10. Work charged for and never performed
11. Failure to resolve possible fraud
12. Package deals which are not in the consumers' interest
13. Instances of faulty repair
14. Failure to detect faulty repair
15. Failure to resolve faulty repair
16. Vehicle design requiring use of modularized or non-standard parts

A remedy was said to be 10 percent effective against a specific problem area if it reduced by 10 percent the likelihood of making the "wrong" choice at each of the decision points in the model associated with that problem area. For example, a remedy 10 percent effective against "instances of faulty repair" would reduce the rate of improper repair on ordinary jobs from 10 percent to nine percent, and the rate of improper repair on package deals and routine maintenance from five percent to 4 1/2 percent. Thus, the number that is entered into the model corresponds closely to a layman's intuition of what constitutes "remedy effectiveness.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. The procedure for entering remedy effectiveness into the model was simplified by:(10 point)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-05	Select and prepare Method options

1.5.1. Functional testing

Functional testing is carried out in order to find out unexpected behaviour of the report. The characteristic of functional testing are to provide correctness, reliability, testability and accuracy of the report output/data

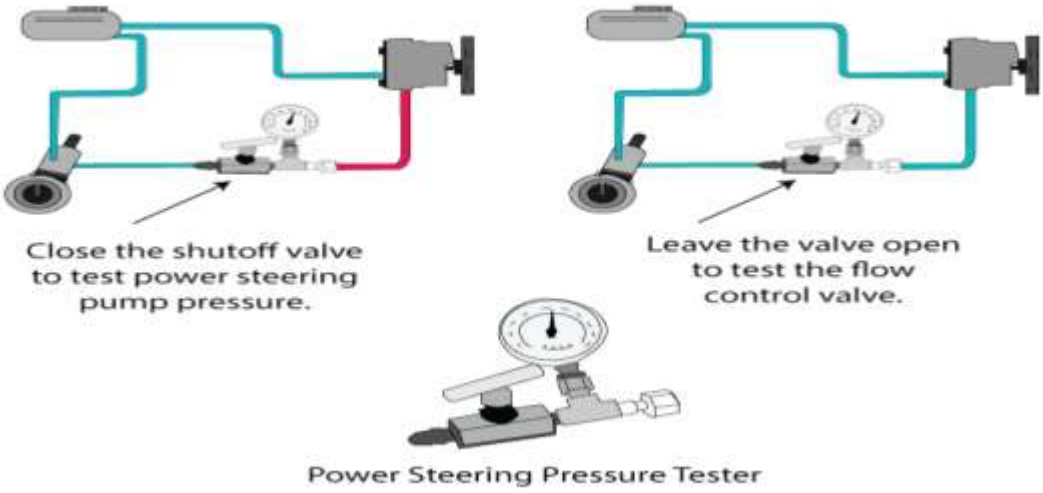
1.5.2. Pressure testing

A power steering pressure test checks the system's fluid pressure; testing the high pressure lines, power steering pump, control valve, and the pressure relief valve. Check for external leaks and top fluid levels before beginning this test. Review manufacturer's specifications and procedures before preceding.

1. With the engine stopped, install the pressure gauge with the shutoff valve in the open position.
2. Start and idle the engine with the valve in the open position. Turn the steering wheel left and right several times to release any air bubbles and bring the fluid to normal operating temperature.
3. With the gauge connected, close the shutoff valve for 5 seconds and compare with manufacturer's specifications. Never hold this valve closed more than 5 seconds unless instructed to do so by the manufacturer of the pump. This will cause the fluid to overheat, possibly damaging the power steering pump. If the reading is not within specifications, the power steering pump is weak and must be replaced.

4. With the shutoff valve in the open position, check the gear housing for leaks by holding the steering wheel against its stop and checking fluid pressure against specifications. Do not hold the wheel in this position for too long. Power steering systems reach pressures in excess of 1000 lbs. per square inch. If the pressure is too low, the internal gear housing may have an internal leak, undetectable during a visual inspection.

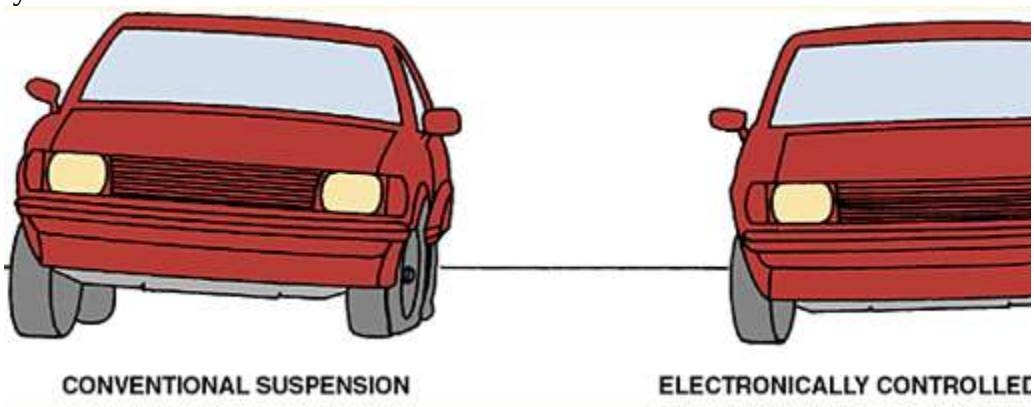
5. Check the flow control valve operation with the shutoff valve in the open position and record the reading at 1000 RPM and 3000 RPM. Compare these two readings against specifications. If these two readings are not within specifications the flow control valve is bad and must be replaced.



1.5.3. Electrical testing

ELECTRONICALLY-CONTROLLED SUSPENSION

Provides a firm suspension feel for fast cornering and quick acceleration, braking, and soft ride. It can help reduce body roll and other reactions better than most conventional suspension systems.

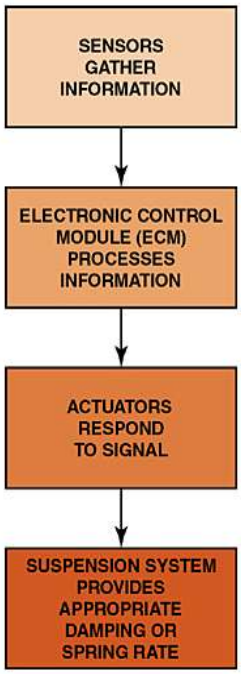


ELECTRONIC CONTROLS AND SENSORS

Sensors and switches - provide input to the electronic control module (ECM), or computer.

ECM **-** is a small computer that receives input in the form of electrical signals from the sensors and switches and provides output electrical signals to the system actuators.

The electrical signal causes an actuator to perform some type of mechanical action.

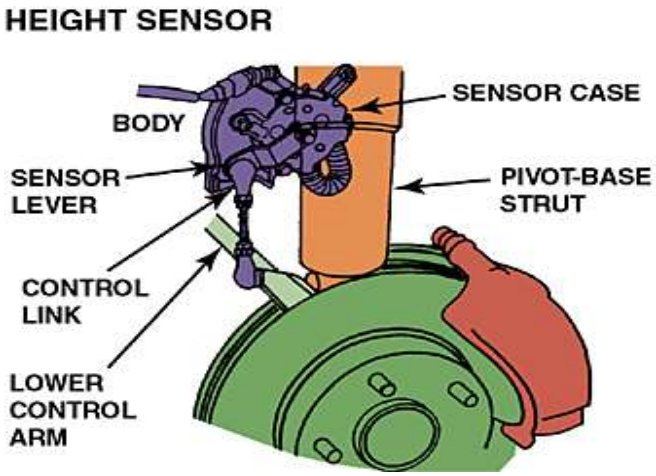


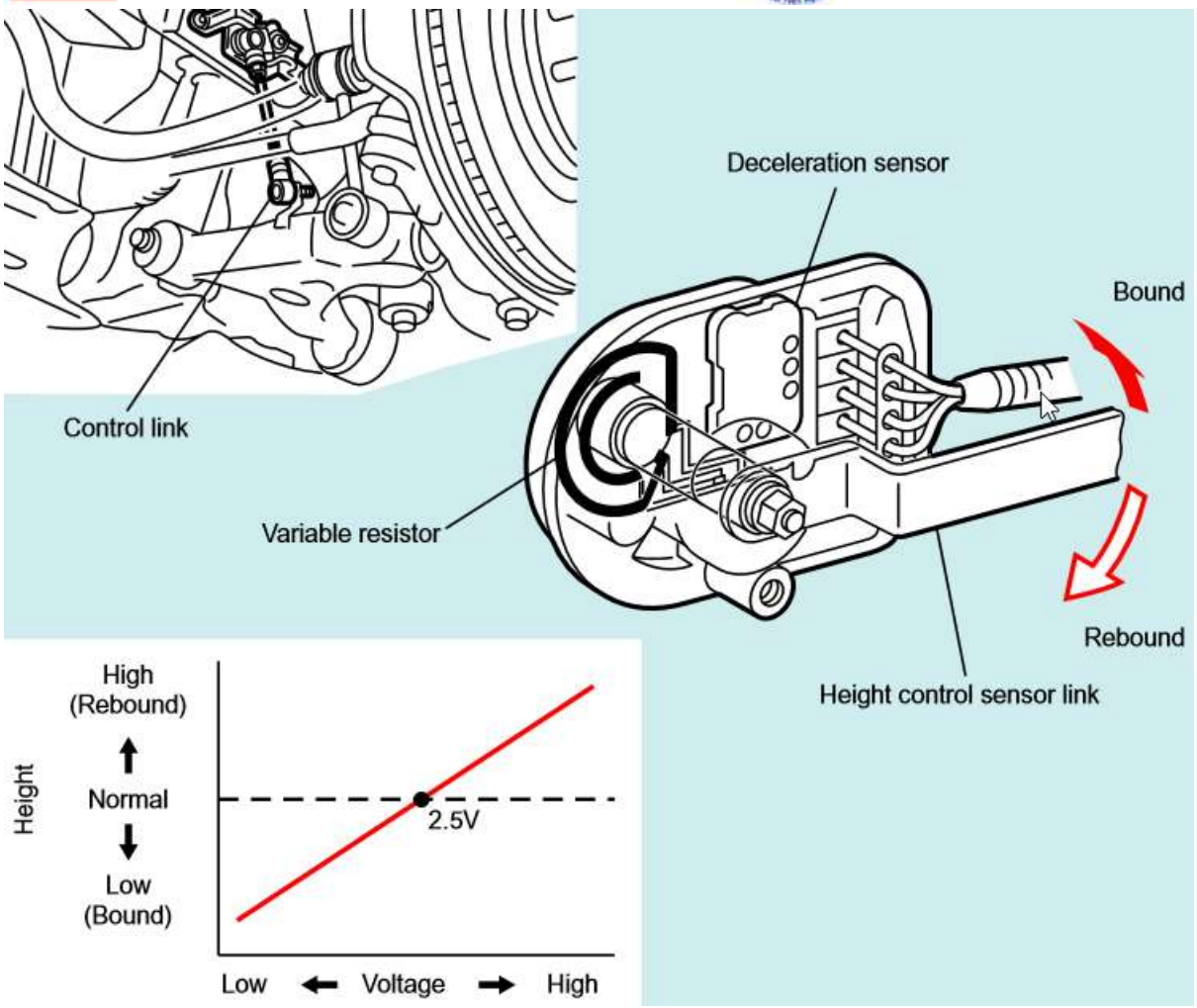
Height Control Sensors - senses the vertical relationship between the suspension component and the body. Its signal indicates to the ECM how high the frame or body is, or how compressed the suspension is.

A typical height sensor, which bolts to the body and connects to the lower control arm through a control link and lever. Four height sensors, one at each wheel, deliver an input signal to the ECM.

A height control sensor is incorporated in each wheel. This sensor converts change in the height of the vehicle into change in the control link rotation angle. Then, the result is detected in the form of voltage change.

When the vehicle becomes higher, the signal voltage becomes higher; when the vehicle becomes lower, the signal voltage falls.



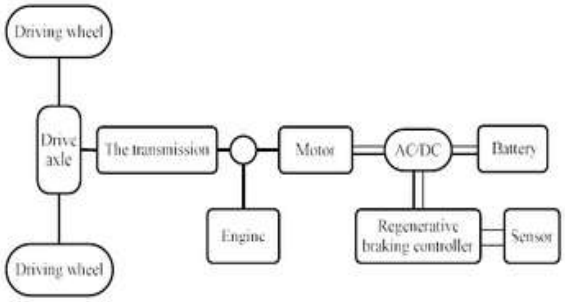


There are five different name of sensors found on electronic suspension systems:

1. An automatic level control sensor
2. An electronic suspension position sensor
3. A position sensor
4. An air suspension sensor
5. A Height Sensor

Test of regenerative braking performance

Regenerative braking is a unique braking technology used in electric vehicles. The system principle is in the case of deceleration braking, the driving motor runs in the power generation state, and relies on the reverse dragging of the wheels to generate electric energy and wheel braking torque. Thus, while slowing down the speed of the vehicle, part of the kinetic energy is converted into electric energy to be fed back to the battery for charging, and the energy feedback is realized



1.5.4. Visual, aural and functional assessments

Steering & Suspension
1. With the engine running, check the operation of the steering by moving the steering wheel, or, on cycle type vehicles, the handle
2. Visually inspect all steering components under the bonnet and under the vehicle
3. Examine the idler arm
4. Visually inspect the suspension

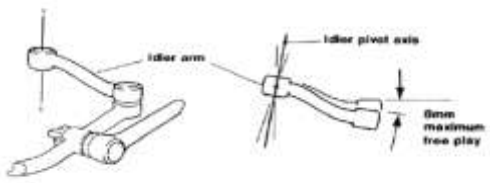
1. **With the engine running, check the operation of the steering by moving the steering wheel, or, on cycle type vehicles, the handle**
Reasons for rejection
1. where a steering wheel is fitted, there is more than 50mm rotational free play
2. the steering wheel is not securely attached to the steering column
3. where steering linkages are fitted to cycle type vehicles, the rotational free play exceeds 10mm measured at the end of the handle bars;
4. the steering wheel is not of the same specification as the one provided by the vehicle manufacturer
2.**Visually inspect all steering components under the bonnet and under the vehicle**
NOTE: Take care with spring-loaded and rubber-bush joints. These components might be designed to have a certain amount of allowable movement.
Reasons for rejection
1. any steering component is missing, cracked or broken or is worn beyond manufacturers limits;
2. any steering component can be seen to have been repaired or modified by heating or welding;
NOTE: Does not apply where an original component has been fitted by the manufacturer or repairs have been conducted to manufacturers specifications.
1. any nut, bolt or locking device is missing or insecure
2. the steering box or rack is not securely fixed to the vehicle
3. there is any movement on the spline between Pitman arm and the steering box or between any thread or tapered joint; (free play due to wear in any steering
component exceeds manufacturers specification (if that specification is not known, free play exceeds 3mm));
4. any power steering component is leaking, damaged or inoperative;
5. any power steering belts are loose, broken, frayed, missing, or cracked through to reinforcing plies.

3**. Examine the idler arm**

If fitted, attempt to move the idler arm in the direction of the pivot axis.

Reason for rejection

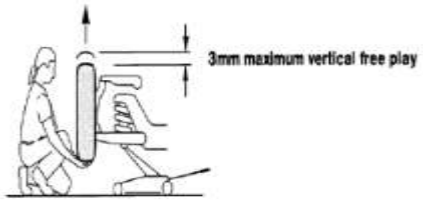
1. the play at the end of the idler arm exceeds 8mm



4. Visually inspect the suspension

Reasons for rejection

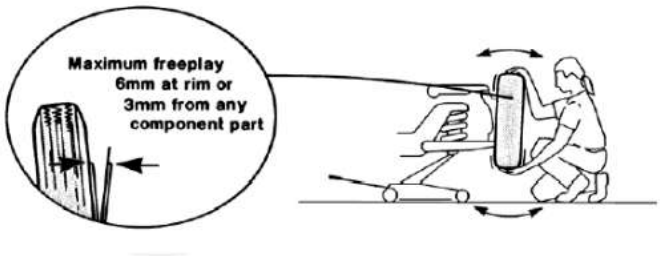
1. any suspension component is broken, insecure, cracked, cut, missing, or can be seen to have been repaired or modified by heating or welding, or is worn beyond manufacturer's limits;
2. any shock absorber or strut is inoperative
3. any chock absorber or strut is not securely mounted;
4. any nut, bolt or locking device is missing or not secure;
5. with the wheels raised, the vertical free play of any wheel exceeds 3mm;



NOTE: Manufacturer's tolerances take precedence over specified free play measurements when performing these checks.

7

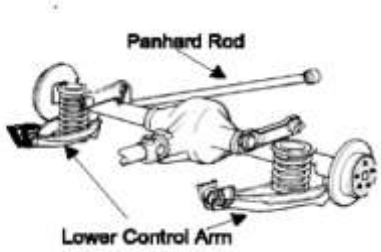
1. with the wheels raised, the free play of the wheel measured at the rim exceeds 6mm in total or 3mm from any component



NOTE: Manufacturer's tolerances take precedence over specified free play measurements when performing these checks.

1. any axle component, U-Bolt, spring hangers, center bolt etc associated with the axle installation or performance is cracked, loose, broken, missing

or worn outside of manufacturers safe working limits;
2. any springs are cracked, broken, missing, displaced more than 10% of their width or in contact with wheels, brakes or the frame;
3. air bags leak
4. any part of the vehicle (excluding wheel rims, tyres and (mudflaps) is closer to the ground than 100mm.
Axle locating devices



NOTE: Superficial crazing is acceptable on rubber bushes. This is often present on rubber suspension components

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1.List the five different name of sensors found on electronic suspension systems: 10 point

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-06	Source and support technical and/or measurement

Source and support technical and/or measurement

Backed by the enormous market knowledge and experience, we are manufacturing and supplying the finest quality range of **Under Vehicle Search Mirror.** This search mirror is designed by utilizing superior quality components under the supervision of our experts at well equipped production unit. In line with predefined industry demands, our entire range is needed while security checks of cars and other vehicles. Prior to delivery, it is examined on certain standards by our quality controllers. We offer this **Under Vehicle Search Mirror** to our clients at market leading rates.

Features:

Durable finish
Easy to fix
Excellent design

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1, what is the advantage of under vehicle search mirror:(10 point)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

Information Sheet-07	Observe warnings

Observe warnings

Difficulty in turning the wheel. If you have power steering, as most cars do these days, then this could indicate the system has a problem. Firstly, check to see if the fluid reservoir is full. If it isn't, fill it up. If the next time you check, it has gone down again, then check under the vehicle for signs of any fluid leakage. Leaks can be in the steering pump, hoses or the steering rack itself.

Steering wheel vibration. While this is often an indication of wheel alignment problems, steering wheel vibration can also indicate a problem with the power steering. A build-up of contaminants in the system can cause the steering wheel to vibrate or 'pulsate' when the wheel is turned fully in one direction or another. A power steering flush would normally fix this problem.

Steering wheel slips when you attempt to turn it or hold it in a turned position. This is another sign that the power steering is failing. Other causes of power steering failure apart from leakage include faulty pumps, worn steering rack mounts and loose or worn steering belts.

Looseness in steering wheel. This is usually caused by worn steering racks and tie rods.

Excessive steering wheel vibration when you accelerate or turn a corner. This is usually caused by faulty or worn tie rods. If allowed to continue, it will cause the whole car to vibrate and eventually lead to loss of steering, so it should be rectified as soon as the problem is discovered.

Vehicle wanders or pulls to one side. This often indicates a problem with a worn steering gear. Premature steering gear wear can be caused by lack of lubrication from power steering fluid, so you should also check for any power steering leaks when replacing a worn steering gear.

Excessive play in the steering wheel can also point to a worn or faulty steering gear. If you have to turn the steering wheel more than an inch before the wheels begin to turn, then you can be fairly certain there is a problem with the steering gear.

Grinding noise when turning the steering wheel. This is yet another indication of a steering gear problem.

Screeching noise when you turn the wheel. This is often caused by a loose or worn power steering belt. This is the belt that connects the power steering pump to the engine. The screeching noise could also be a symptom of low power steering fluid levels, as mentioned before.

Foaming or discoloured power steering fluid. This indicates that air or water has gotten into the system and the fluid is not lubricating the components properly.

Self-Check -7	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1, The problem of Steering wheel vibration is:10 point

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**
You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

List of Reference Materials

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7. Automotive Mechanics 10th Ed. by: Crouse and Anglin 3.
8. Automotive Excellence 4. Hilton’s Truck & Van Repair Manual (93-97)