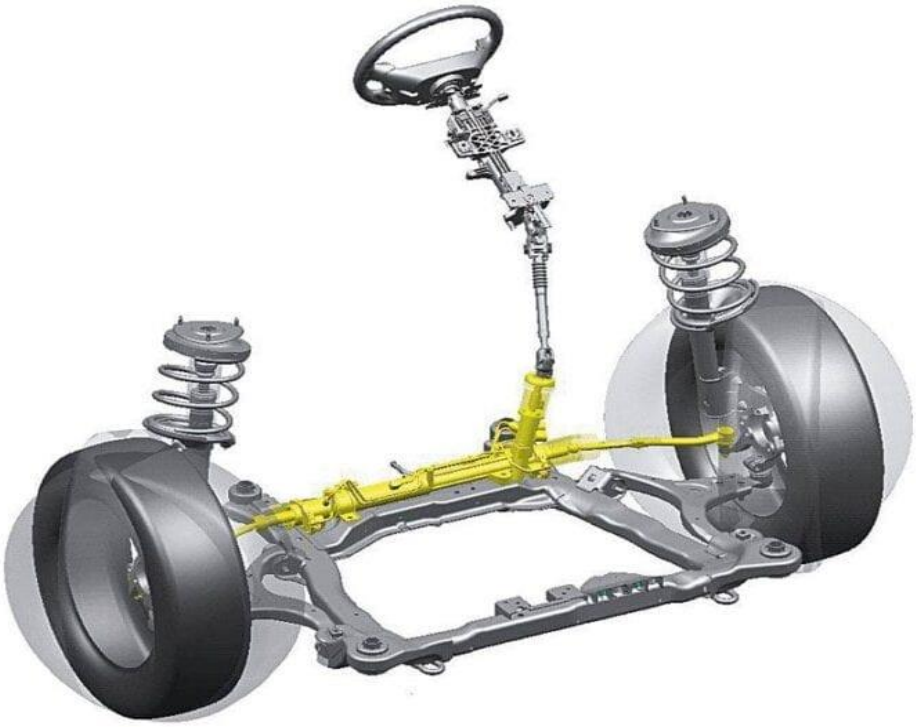
Automotive Mechanics

Level-II

Based on March 2022, Curriculum Version 1



Module Title: - Performing minor under chassis systems service

Module code: EIS AUM2 M06 0322

Nominal duration: 60 Hour

Prepared by: Ministry of Labor and Skill

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MINISTRY OF LABOR AND SKILLS

Addis Ababa, Ethiopia

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Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

A	Area
ABS	Anti-Lock brake system
DMM	Digital MultiMate
ECM	Electronic control module
EVO	Electronic variable orifice.
F	Force
FWD	Four wheel Driver
HEPA	High-efficiency particulate air
KM.	Kilometer
MAX	Maximum
MIN	Minimum
MM	Millimeter
P	Pressure
RWD	Rear Wheel Driver
TTLM	Teaching, Training and Learning Materials

Introduction to module

In the automotive field, required to carry out basic services of defects on automotive running gear assemblies such as steering suspension and brake systems. The module involves basic check/test to identify fault, removal, and disassembly, replacement of worn or failed components, reassembly and reinstallation according to workplace requirements.

This module is designed to meet the industry requirement under the automotive mechanics level II occupational standard, particularly for the unit of competency: **Performing minor under chassis systems service.**

This module covers the units:

- Minor service to under chassis systems
- Basic inspection/test
- Minor repair
- Work area and maintain the equipment

Learning Objective of the Module

- Undertake minor service to under chassis systems
- Conduct basic inspection/test
- Carrying out minor repair
- Clean up work area and maintain the equipment

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Prepare to undertake minor service to under chassis systems

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Hydraulics and pneumatics
- Friction materials
- Types of brake systems
- Overview of circuits and designations of pneumatic brake
- Suspension system
- Mechanical and hydraulic Steering systems

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Principles of hydraulics and pneumatics
- Characteristics of friction materials
- Types of brake systems
- Overview of circuits and designations of pneumatic brake
- Identifying Suspension system
- Identifying Mechanical and hydraulic Steering systems

1.1 Principles of hydraulics and pneumatics

1.1.1 Principles of hydraulics

The basic principles of hydraulics are few and simple and are as follows:

- Liquids have no shape of their own.
- Liquids will NOT compress.
- Liquids transmit applied pressure in all directions.
- Liquids provide great increase in work force.

Pressure and Force the terms force and pressure are used extensively in the study of fluid power. It is essential that we distinguish between these terms. Force means a total push or pull. It is push or pull exerted against the total area of a particular surface and is expressed in pounds or grams. Pressure means the amount of push or pull (force) applied to each unit area of the surface and is expressed in pounds per square inch (lb/in2) or grams per square centimeter (gm/cm2). Pressure may be exerted in one direction, in several directions, or in all directions.

Computing Force, Pressure, and Area A formula is used in computing force, pressure, and area in hydraulic systems. In this formula, P refers to pressure, F indicates force, and A represents area.

Force equals pressure times area. Thus, the formula is written F = P x A

Pressure equals force divided by area. By rearranging the above formula, this state may be condensed into the following: P = F divided by A. Since area equals force divided by pressure, the formula for area is written as follows: A = F divided by P.

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 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.

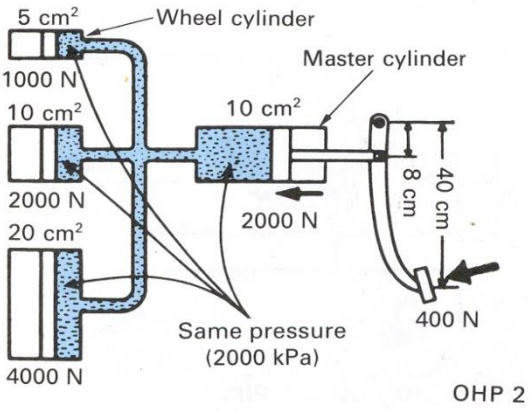


Figure 1-1 Pascal's Law

If a vehicle design requires a larger braking force at the front wheels from example the designer will specify larger cylinders for the front.

1.1.2 Principles of pneumatics

The principles of pneumatics are the same as those for hydraulics, but pneumatics transmits power using a gas instead of a liquid. Compressed air is usually used, but nitrogen or other inert gases can be used for special applications. With pneumatics, air is usually pumped into a receiver using a compressor.

Pneumatics makes use of an air compressor to reduce the volume of the air in order to increase its pressure. This then moves through a filter into pneumatic tubing, where it's controlled by valves before reaching an actuator which does the work at the end of the process.

Explaining the Basic Principles of Pneumatic Systems. Pneumatic power systems are used for an ever increasing variety of applications. Fluid power is a way to move big stuff, move it fast, and do it in a really small package. Fluid power uses a gas or liquid under pressure to move a piston or shaft to do work.

Understanding the Difference between Pneumatic and Hydraulic Systems

The important principles of pneumatics are essentially the same as hydraulic systems, but there are several distinctions to keep in mind.

2. Pneumatics utilizes gas instead of liquid to transfer power
3. Because gas can be compressed, there is a delay in movement in pneumatic systems
4. Pneumatics generates higher energy costs due to energy lost from heat production during compression
5. Hydraulics handles greater force than pneumatics

Air is pumped into a receiver and compressed, ready to be used by the pneumatic system as needed. The air taken from the area around the compressor is filled with contaminants such as dirt, dust, and water vapor. To combat this, strong filters are installed to keep the air clean and dry.

Advantages of Pneumatics over Hydraulics

The use of gas offers pneumatics several advantages over hydraulics.

- Pneumatics are used in food applications more often than hydraulics because there is less chance for contamination, whereas hydraulics are used in industrial equipment for their power and control.
- Pneumatic systems are common in medicinal facilities due to their range of sizes; they are installed where space cannot be taken up by large equipment.

- Lower pressures in pneumatic systems make them more appropriate for components made of lighter and thinner materials like plastics and aluminum. Hydraulic systems work better for parts made of steel or ductile/gray cast iron
- Positioning accuracy rivaling electromechanical applications can be achieved in pneumatics through electronic controls. As a result, chemical plants favor pneumatic systems for their precision over hydraulics and electromechanical systems. Fluid power systems combined with electronics adds incredible control and flexibility to pneumatics

1.2 Characteristics of friction materials

- **Friction Level.**

The coefficient of friction should be sufficiently high to limit brake pedal effort. It should not be so high that it causes grab, or in the extreme cases lock or sprag. In such a situation rotation of the drum becomes impossible. The friction material must be com-patible with the degree of self-energization. The average coefficient of friction of modern friction materials is between 0.3 and 0.5.

- **Resistance to Heat Fade.**

This property allows a lining or pad material to retain its coefficient of friction with an increase in rubbing temperature of the drum and shoes or disc and pads. A decrease in the coefficient of friction requires greater brake pedal effort and results in poor braking response. The changes in the coefficient of friction as a consequence of rising working temperatures are also partly caused by the additional curing of the pad due to chemical changes in the binder resin (Fig. 28.32). A progressive reduction in the frictional level in the higher temperature range may be acceptable. A rapid decrease in the coefficient of friction severely reduces the braking power capability specifically when the vehicle experiences long descents or continuous stop-start travel.

- **Recovery from Fade.**

This is the ability of a friction material to return to its original friction level after cooling once brake lining or pad temperature fade has occurred. A good quality material restores its frictional characteristics on cooling, even after repeatedly subjected to severe heating. In case of an inferior material, the poor recovery is principally due to chemical breakdown in the ingredients. The friction level may be permanently altered causing hardening, cracking, flaking, and charring or even burning of the linings or pads. If the thermoplastic binder resins are used with the lining or pads a deposit may form on the rubbing surfaces, which may change the friction properties of the material.

- **Resistance to Wear.**

The life of a friction material, for both lining and pad, depends to a great extent upon the rubbing speed and pressure because they are responsible for material wear. The wear is also greatly influenced by the working temperature. At the upper limits of the lining or pad temperature range, the material structure is weakened, resulting in a higher wear rate.

- **Resistance to Rubbing Speed.**

Practically, the coefficient of friction between two rubbing surfaces slightly reduces with the increase of speed, specifically at the higher operating temperature range although it should be independent of speed. But a low quality friction material may exhibit a high friction level at low rubbing speeds and may cause judder and grab

- **Resistance to the Intensity of Pressure.**

As per the laws of friction, the coefficient of friction should be independent of the pressure holding the rubbing surface together. But present friction materials are generally com-pounds, which are held together with resin binders; as a result pressure between the rub-bing surfaces reduces friction level to some ex-tent. A pressure-stable lining produces deceleration proportional to the pedal effort. But a pressure-sensitive material requires a rela-tively greater pedal force to produce a given braking effort.

- **Resistance to Water Contamination.**

Principally all friction materials to some extent are affected by water contamination. Therefore, a safe margin of friction level should be available for operation with wet conditions. Good quality friction materials should recover quickly and progressively to their original friction level during the drying out process. A poor quality material may either recover very slowly or may have over-recovery characteristic. Over-recovery tendency causes brake-grab and even wheel-lock under certain driving conditions.

Resistance to Moisture Sensitivity.

Atmospheric dampness, humidity or dew may increase the friction level for the first few applications. They may develop the brakes noise and cause brake-grab for a short time. Moisture-sensitive friction materials should not be used with brakes having high self-energizing characteristics.

1.3 Types of brake systems

1. On the Basis of Power Source

The power source which carries the pedal force applied by the driver on brake pedal to the final brake drum or brake disc in order to de accelerate or stop the vehicle the braking systems are of 6 types-

1) Mechanical braking system
2) Hydraulic braking system
3) Air or pneumatic braking system
4) Vacuum braking system
5) Magnetic braking system
6) Electric braking system

2. On the Basis of Frictional Braking Contact

On the basis of the final friction contact made between the rotating brake components i.e. brake drum or disc rotor and the brake shoe the braking systems are of 2 types.

(i) Internal expanding brakes (e.g. - drum brakes)

(ii) External contracting brakes (e.g. disc brakes)

3. On the Basis of Application-

On the basis of method of applying brakes, braking systems are of 2 types-

(iii) Foot or service brakes

(iv) (ii) Hand or parking brakes

4. On the Basis of Brake Force Distribution

(v) (Single acting brakes

(vi) Dual acting brakes

1.4 Suspension system

A vehicle's under chassis have three main parts: clutch, steering and suspension. Clutch connects the engine to the drive shaft, to transfer power from the engine to the wheels. Steering steers the wheels left or right. Lastly, the suspension absorbs shock while driving on an uneven ground.

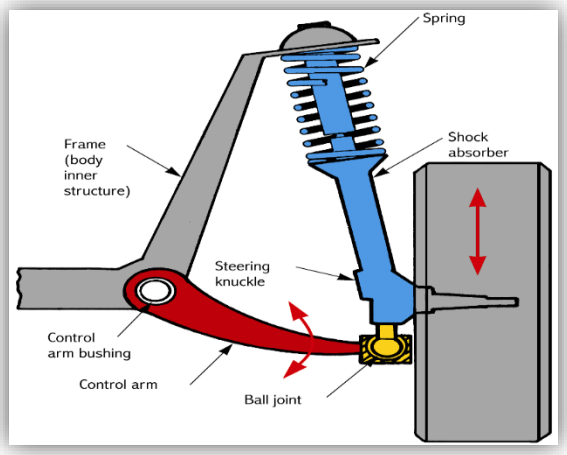


Figure 1-2 Suspension system layout

Suspension system is designed to ease the shocks of road surface irregularities. Thus, improve riding comfort and stability as well as the tire's road holding characteristics. Suspension system is located between the frame and the wheels. It is combined with springs, shock absorbers, stabilizers, and so forth.

1.4.1 Functions of suspension system

1) It acts, together with the tires, to absorb and damp the various vibrations, oscillations, and shocks received by the vehicle due to irregular road surface.

2) It transmits driving and braking force, which are generated due to friction between the road surface and the wheels, to the body.

3) It supports the body on the axles and maintained the proper geometrical relationship between body and wheels. 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 device

1.4.2 Types of Suspension

Suspension can be broadly divided into two types according to its construction.

1. Rigid Axle Suspension

In vehicles having a rigid axle suspension system, the right and left wheels are connected by a single axle which itself is fitted to the body and the frame via springs (leaf springs or coil springs). Due to its great strength and simple construction, the rigid axle suspension system is widely used on the front and rear wheels of buses and trucks, and on the rear wheels of passenger cars.

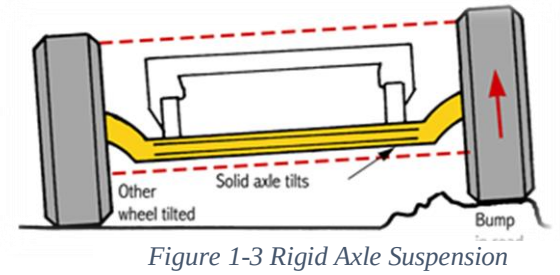


Figure 1-3 Rigid Axle Suspension

2. Independent Suspension

In vehicles having an independent suspension system, the right and left wheels are not connected directly by an axle. The suspension is fitted to the body and the frame in such as way that both wheels can move independently without affecting each other.

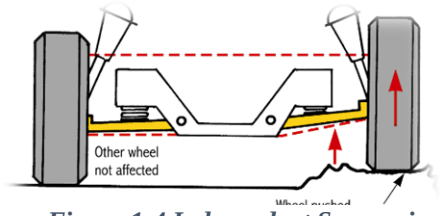


Figure 1-4 Independent Suspension

The independent suspension system is commonly used with the front wheels of passenger cars and small trucks and, more recently, with the rear wheels of passenger cars as well.

1.4.3 Components of Suspension System

A. Spring

Carry the weight of the vehicle and absorb shock forces while maintaining correct riding height. They are compressible links between the vehicle's frame and body and the tires. Doing this, they dampen road shock and provide a comfortable ride.

a) Springs Function

- ✓ Allows suspension movement for better tire to road contact
- ✓ To maintain correct chassis ride height.
- ✓ To assist in absorbing road shock.

Automotive springs are generally classified by the amount they compress under a specific load. This is referred to as the spring rate. A force (weight) applied to a spring causes it to compress in direct proportion to the force applied. When that force is removed, the spring returns to its original position if it is not over-loaded. This is why a heavy vehicle needs stiffer springs than a lightweight car. This storing and releasing of energy causes the spring to "oscillate" or bounce several times until releasing all excess energy.

While this oscillation is occurring, the tire will change its relative position to the road surface, causing a scrubbing of the tire tread, as well as handling problems for the driver.

b) Types of spring

I. Coil springs

Coil springs are made from rods of special spring steel formed into the shape of a coil. When a load is placed on a coil spring, the entire rod is twisted as the spring contracts. In this way, the energy of the external force is stored, and shock is cushioned.

Figure 1-5 Coil spring

II. Leaf springs

Leas springs are made of a number of curved bands of spring steel, called "leaves", stacked together in order from shortest to longest. This stack of leaves is fastened together at the center with a center bolt or a rivet. Also, to keep the leaves from slipping out of place, they are held at several places with clips.

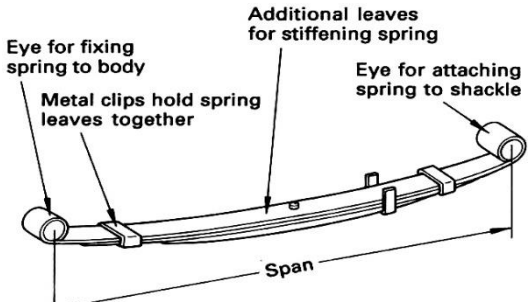


Figure 1-6 Leaf springs

Both ends of the longest (main) leaf are bent to form spring eyes, used to attach the spring to the frame or to a structural member such as a side member. Generally, the longer a leaf spring, the softer it will be. Also, the more leaves in a leaf spring, the greater the load they will withstand, but on the other hand, the spring will become firmer and riding comfort will suffer. The curvature of each leaf is called "nip". Since the nip of a leaf is greater the shorter the leaf, each leaf curves more sharply than the one above it in the stack. When the center bolt is tightened, the leaves flatten somewhat, causing the ends of the leaves to press very tightly against one another. The overall curvature of the leaf spring is called "camber".

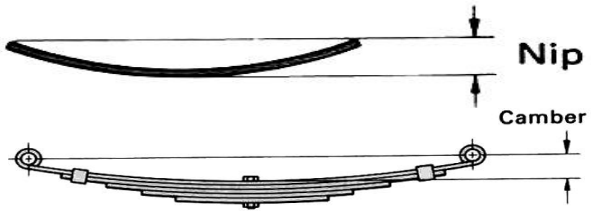


Figure 1-7 Parts of leaf spring

III. Air springs

Air springs make use of the fact that air has elastic or springiness when compressed. Air springs have the following characteristics.

They are extremely soft when the vehicle is not loaded, but their spring constant can be increased as increasing the air pressure inside the chamber increases the load.

This provides optimum riding comfort both when the vehicle is lightly loaded, and when it is fully loaded.

Figure 1-8 Air springs

The height of the vehicle can be kept constant, even if the load changes, by adjusting the air pressure However, in air suspensions using air springs, devices for controlling the air pressure and compressors for compressing air, etc., are necessary, so the suspension becomes complex

IV. Torsion bar springs

A torsion bar spring (usually simply called a torsion bar) is a spring –steel rod that uses its torsional elasticity to resist twisting. One end of the torsion –bar is anchored to the frame or other structural member of the body, and the other end to a component that is subjected a torsional load. Torsion bar springs are also used to make stabilizer bars.

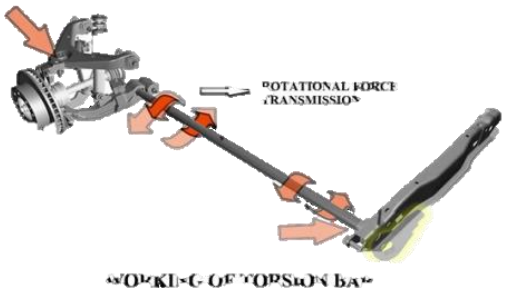


Figure 1-9 Torsion bar springs

B. Suspension Control Arms

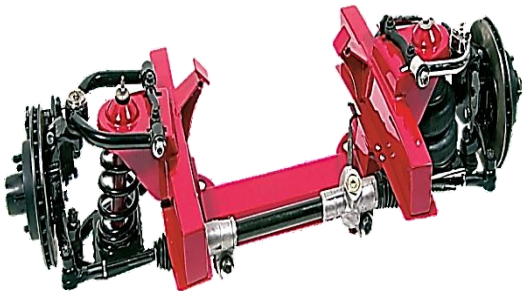


Figure 1-10 Suspension Control Arms

- Control arms control the path of travel that the
- Tire can have during jounce and rebound.
- The most common arrangement of these control arms is to have a shorter one on top and a larger one on the bottom.
- This system's name is "short arm, long arm"

a) SALA suspension

Because of the difference in their sizes, the control arms move in different arcs during jounce and rebound.

The smaller, upper control arm moves in a larger arc and tends to move the top of the tire only.

Figure 1-11 SALA suspension

The larger, lower arm moves in a much smaller arc, and moves the bottom of the tire very little.

C. Ball joint

The outside pivot point for the control arm is usually a ball joint.

✓ The construction of a ball joint is much like your shoulder joint.

✓ It allows motion in a circular direction and in an arc, but not laterally (in-and out).

✓ Ball joint construction includes a housing, a ball and tapered seat, a bearing, and some form of preload device.

Ball joints come in two basic designs, compression loaded and tension-loaded, and are used as either a weight carrying pivot or a friction pivot. The location of the weight carrying joint is closest to the seat of the spring or torsion bar.

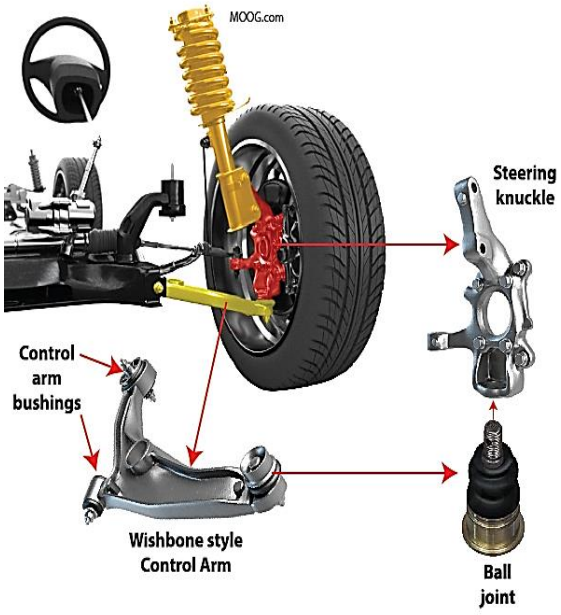


Figure 1-12 Ball joint

The design of the compression joint allows the weight of the vehicle and the upward push of the tire and steering knuckle to compress the ball stud into the housing.

The tension joint is just the opposite, vehicle weight and the push of the tire and knuckle pull the ball stud away from the housing.

In either case, the result is to have the ball stud in constant contact with the bearing, which is the wear surface.

Most vehicles today use a compression joint for the friction joint and a tension joint for the weight carrying joint.

Figure 1-13 Ball joint

D. Shock absorber

A shock absorber is a tubular hydraulic device placed near each wheel to control or dampen spring oscillations. One end of the shock absorber attaches to the vehicle body or frame. The other end attaches to a moving suspension part such as the axle housing or a control arm. Movement of the spring then causes the shock absorber to lengthen and shorten.

The purpose of the hydraulic shock absorber is to dampen spring oscillations. It does not support the weight of the vehicle, nor does it affect vehicle height.

Figure 1-14 Shock absorber

a) Shock Absorber Operation

It is basically an oil-filled cylinder or tube in which a piston moves up and down.

This forces the oil or hydraulic fluid in the cylinder to flow through small fluid passages or orifices in the piston. The resulting fluid friction limits spring bounce.

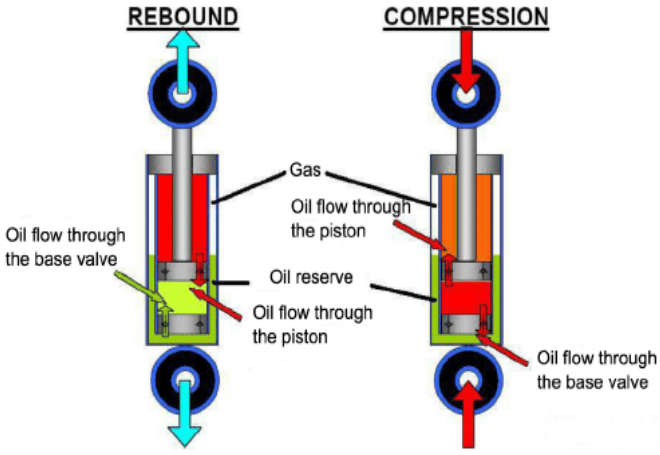


Figure 1-15 Shock Absorber Operation

Other Types of Shock Absorber

Spring-Assisted shock Absorbers – This type combine spring action with shock absorber action. This helps maintain proper vehicle height regardless of load.

Adjustable Shock Absorber – It has three positions that can be selected to change the firmness of the shock absorber action. Turning the upper dust tube one way produces a softer ride. Turning it the other way produces a harder ride. In some cars, the driver can change the shock absorber setting by moving a switch on the instrument panel.

Air Shock Absorber – Have a rubber boot surrounding the shock absorber. This forms a sealed air chamber which is filled with compressed air. The compressed air increases the load-carrying capacity of the vehicle while maintaining proper rear-end height. Many vehicles have automatic level control or electronic level control.

The two rear air shock absorbers are connected by air lines to an air compressor on the vehicle. At least one of the shock absorbers includes a height sensor. It signals the electronic control module (ECM) when the load in the rear of the vehicle has caused a change in vehicle height.

The ECM then switches on the air compressor to add air to the shock absorber. Removing the load causes the ECM to open the air valve. This bleeds air from the system. Some vehicles have electronically-adjusted air shocks or air struts at all four wheels

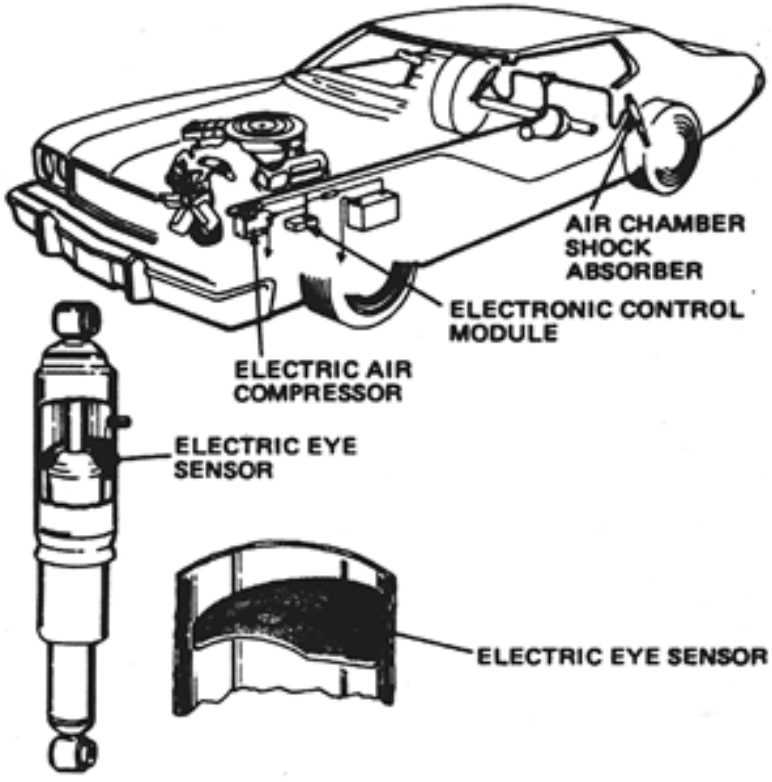


Figure 1-16 Electrical shock absorber

1.5 Mechanical and hydraulic Steering systems

1.5.1 Purpose and operation of Steering systems

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 assisted.

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 arms or steering arms.

The steering knuckles then pivot inward or outward on ball joints. This moves the wheels and tires to the left or right for steering.

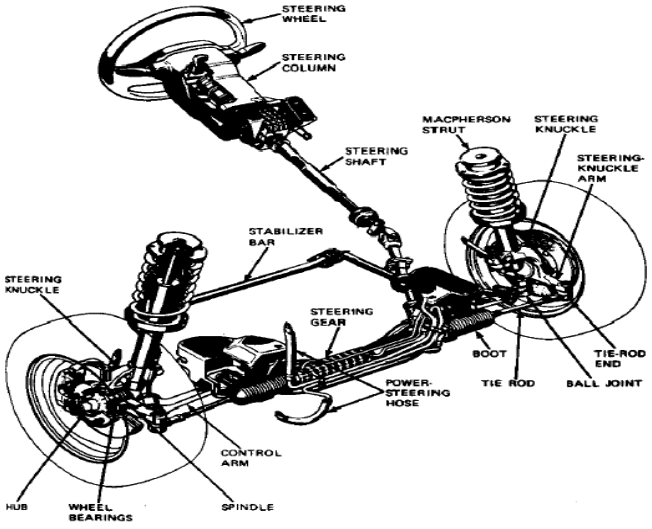


Figure 1-17 Steering system layout

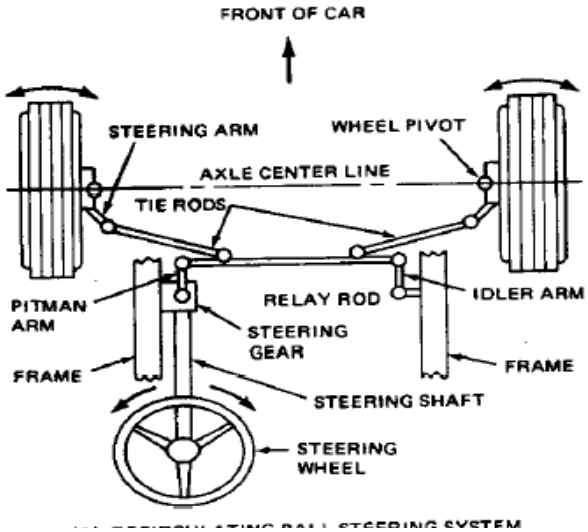


Figure 1-18 Recirculating ball steering systems

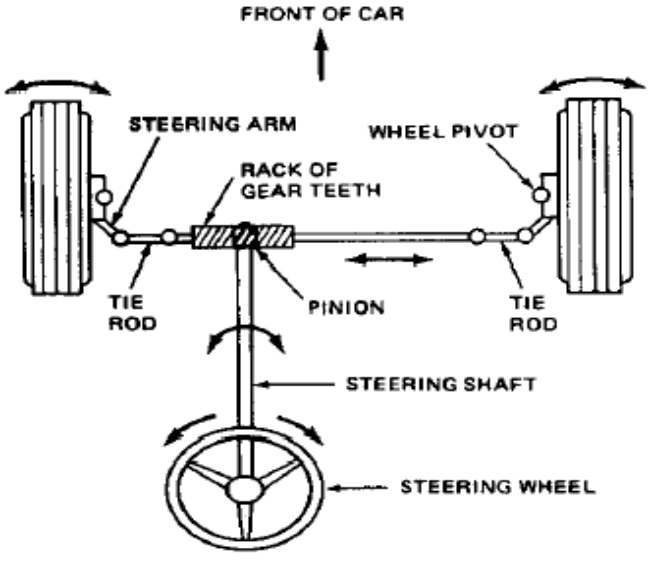


Figure 1-19 Rack and pinion steering system

1.5.2 Components of steering system

- The steering wheel and steering shaft that transmit the driver's movement to the steering gear.
- The steering gear that increases the mechanical advantage while changing the rotary motion of the steering wheel to linear motion.
- The steering linkage that carries the linear motion to the steering arms.

1.5.3 Types of Steering Gears

Two types of steering gears are widely used in automotive vehicles. These are the recirculating-ball steering gear and the rack-and-pinion steering gear. Both steering gears are made in manual and power versions.

A few vehicles have a worm-and-roller steering gear. It is similar to the recirculating-ball. Both use a pitman arm and the parallelogram steering linkage. The pitman arm connects the steering-gear output shaft to the steering linkage.

A. Recirculating-Ball Steering Gear

Trucks and large cars often have a recirculating-ball steering gear. It has a sector gear on the inner end of the output shaft. A sector gear is a section of gear teeth from a gear wheel. The output shaft is called the sector shaft or pitman-arm shaft. The teeth on the sector gear mesh with the teeth of a ball nut. It rides on the worm or worm gear that connects to the end of the steering shaft. Balls roll in grooves inside the ball nut and the steering shaft. Balls roll in grooves inside the ball nut in the worm.

As the steering shaft rotates, the worm forces the balls to roll in the grooves. The balls, as they roll, force the ball nut to move up or down to the worm. Movement of the ball nut forces the pitman-arm shaft to turn. This swings the pitman arm, which forces the steering linkage to pivot the wheels for steering.

The balls are the only contact between the worm and nut. This reduces friction. The balls are recirculating balls because they recirculate from one end of the ball nut to the other end during steering. As the balls reach the end of the groove in the ball nut, they enter the return guides. The balls then travel back to the other end of the ball nut.

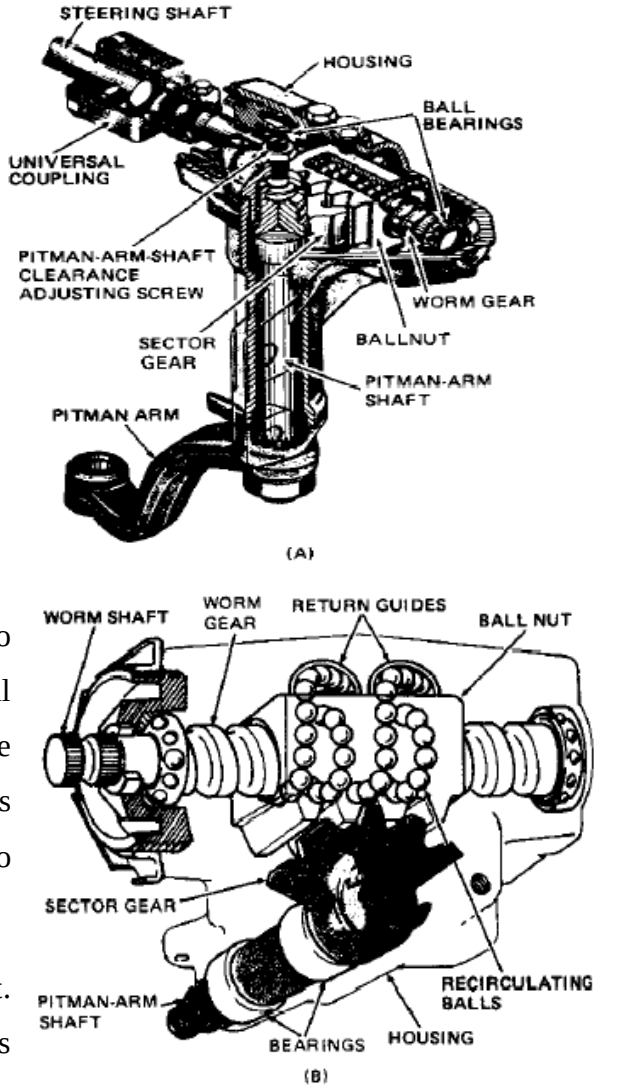


Figure 1-20 Manual recirculating-ball steering gear. (A) Cutaway to show construction. (B) Phantom view of nut and recirculating balls. (Chrysler Corporation, Ford Motor Company)

B. Rack-and-Pinion Steering Gear

Most smaller and down-sized vehicles use a rack-and-pinion steering gear. It has a pinion gear on the end of the steering shaft that meshes with a flat rack of gear teeth. Tie rods connect the ends of the rack to the steering arms. As the steering wheel turns, the pinion gear moves the rack to the right or left. This moves the tie rods and steering arms which turn the steering knuckles and wheels inward or outward.

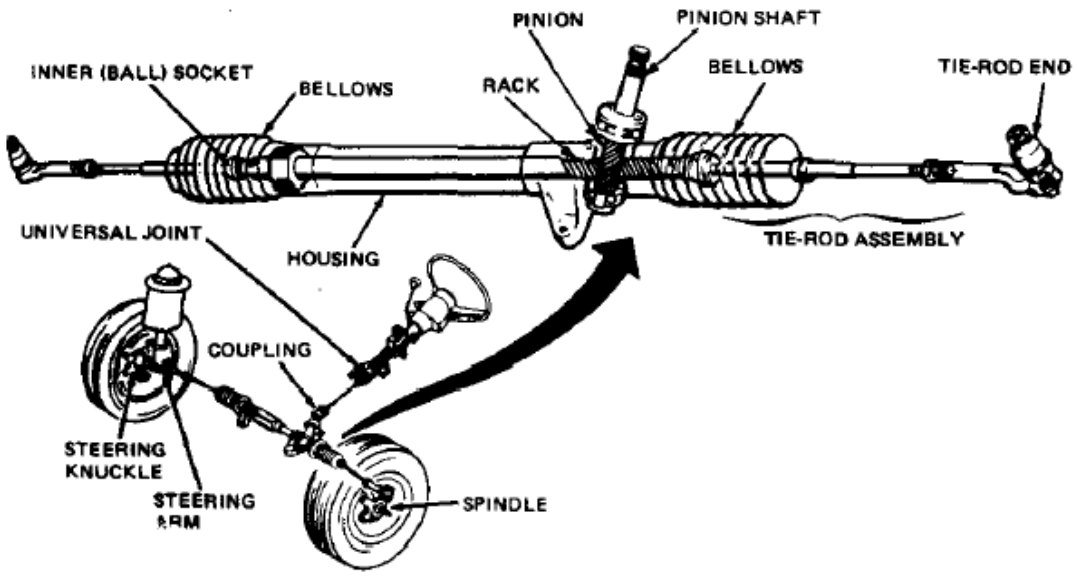


Figure 1-21 Rack-and-Pinion Steering Gear

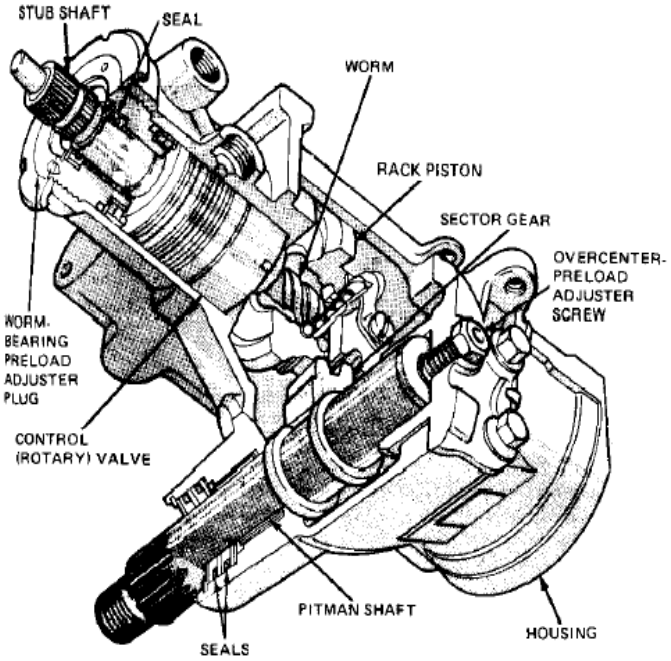
The inner ends of the tie rods have balls which fit into ball sockets on the ends of the rack. This allows the outer ends of the tie rods to move up and down with the steering knuckles and wheels. Flexible rubber boots or bellows protect the steering gear from dust and water.

Many steering systems have an intermediate steering shaft between the steering column and the steering gear. The intermediate shaft has a universal joint at the upper end and a flexible coupling at the lower end. These help prevent road shock and noise from passing up through the steering column to the driver.

1.5.4 Power Steering

Power Steering has an energy source that aids the driver in turning the wheels for steering. Most automotive power-steering systems are hydraulic. A pump supplies high-pressure fluid when the driver turns the steering wheel. This provides most of the required steering effort. Some cars have electronic power steering. An electric motor provides the power assist.

A. Types of Power Steering

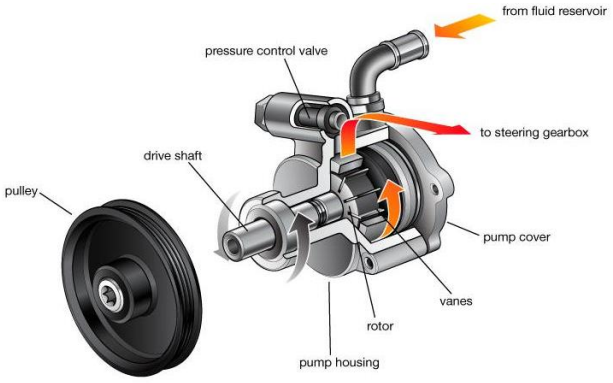


Most power-steering systems are basically a manual steering system with a power booster added. In a power recirculating-ball steering gear, the booster is a power cylinder and piston built into the steering gear. This is an integral power steering because the power booster is integral with the steering gear. Figure 29 shows a power rack-and-pinion steering gear. It also has a built-in power cylinder and piston. A linkage-type power steering can be attached to manual steering systems that have a pitman-arm steering gear. The power cylinder connects between the vehicle body or frame and the steering linkage to provide the power assist.

All hydraulic power-steering systems work in the same general way. The hydraulic pump pressurizes the fluid. Steering effort applied to the steering wheel causes the control valve to open and close fluid passages. These either admit pressurized fluid into the power cylinder, or relieve the pressure. The pressurized fluid causes the piston to move, providing most of the steering effort.

B. Power-Steering-System Components

The power-steering hydraulic system includes a control-valve assembly and a power cylinder. In addition, the system has a hydraulic pump, fluid reservoir, and connecting hoses. The reservoir may be attached to the pump or separately mounted. A filter may be located in the reservoir or hose to remove dirt and particles from the fluid. Some power steering systems also have a fluid cooler.



1. Power-Steering Pump. The pump usually mounts at the front of the engine crankshaft pulley

The pump can produce high pressure- up to 2000 psi (13,800 kPa) in some systems. Figure 32 shows a vane-type -power steering pump. The rotor turns in an oval cam ring inside the pump housing. As the rotor turns, the area between the rotor, cam ring and vanes increases and decreases in size. This forces the pressurized fluid through the pressure fitting to the pressure hose. Gear and roller-type power-steering pumps are also used. Some pumps are driven by an electric motor instead of the engine.

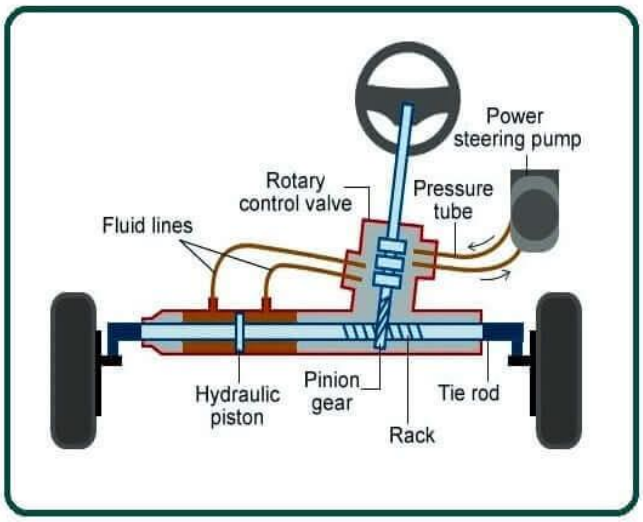


Figure 1-22 Power-Steering-System Components

Hoses and Fittings. Most power-steering systems have a pressure hose and a return hose. The hoses and fittings provide the fluid path between the power-steering pump and the control valve. They are made to take high pressure and flexing. The hoses also help reduce noise from pump pulsations.

Fluid Cooler. Some vehicles with air conditioning and high under hood temperatures have a small power-steering-fluid cooler. It prevents excessive fluid temperature that could damage seals, vanes and other parts. The fluid cooler may simply be a loop in the tubing or a small heat exchanger at the front of the vehicle. On some vehicles, the remote-mounted reservoir provides the necessary fluid cooling

Power-Steering Fluid. Several different hydraulic fluids are used as power-steering fluid. Some manufacturers specify either type F or Dextron II automatic transmission fluid. Other manufacturers use a special power-steering-fluid. It is made to take the high temperatures and pressure. Only the fluid recommended by the vehicle manufacturer should be used in power steering systems.

Power-Steering Pressure Switch. Some vehicles have a power-steering pressure switch on the pressure line between the pump and the steering gear. The switch signals the engine control module to increase engine idle speed when pump pressure or power-steering load is high. The switch position (open or closed) can be read through the diagnostic-connector with a scan tool.

Power Recirculating-Ball Steering Gear

A recirculating-ball steering gear has an integral power cylinder and piston. The ball nut is part of the power piston.

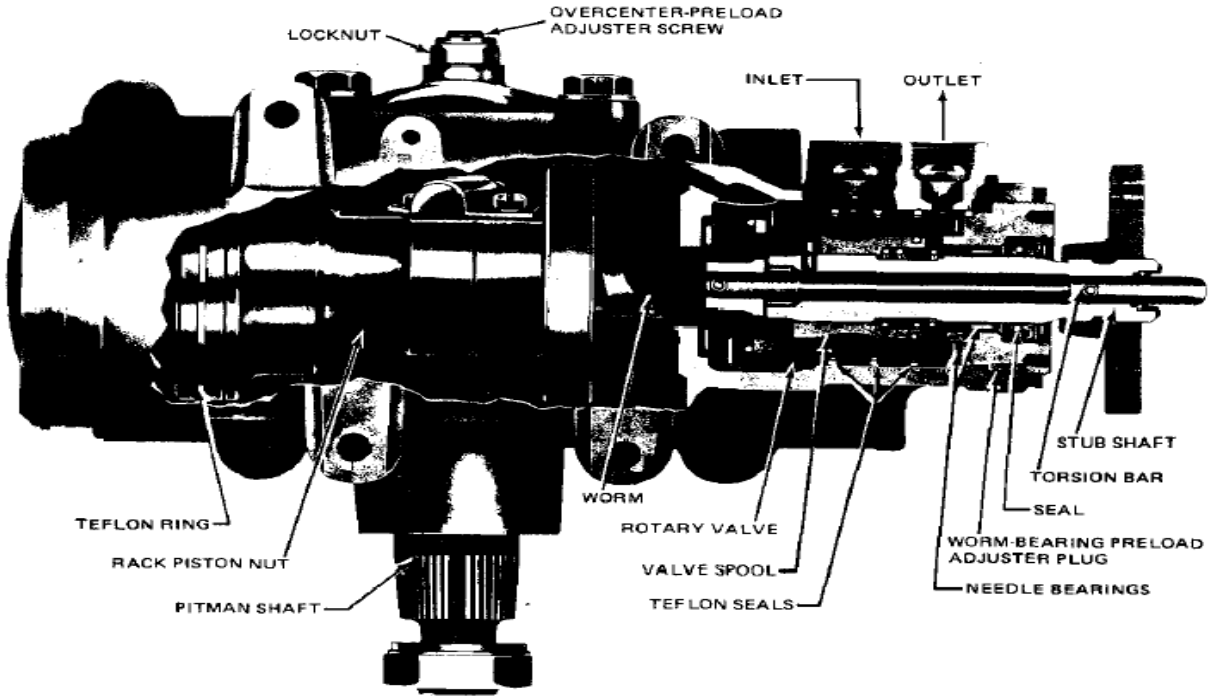


Figure 1-23 Power Recirculating-Ball Steering Gear

Applying hydraulic pressure at either end of the piston assists nut and sector-gear movement. Hydraulic pressure is admitted to one or the other end of the piston by the rotary valve. It connects through a torsion bar to the steering shaft. When the steering wheel turns, steering resistance at the front wheels causes the torsion bar to twist. As it twists, it opens the rotary valve. This sends fluid under pressure to one or the other end of the piston. Which end of the fluid is sent to depend on the direction of the steering wheel turns?

The amount of fluid admitted is determined by the resistance at the vehicle wheels. With greater resistance, the harder the steering wheel must be turned. This twists the torsion bar more which opens the rotary valve more and allows more fluid to enter. The resulting power assist is greater.

The action of other integral recirculating-ball steering gears is similar. Some have a spool valve instead of a rotary valve. As the worm moves, it pivots a pivot lever. This moves the spool valve so that pressurized fluid is directed to one of the power piston.

Power Rack-and-Pinion Steering Gear

A fluid-flow in a power rack-and-pinion steering gear. A torsion bar connects to the control valve. When the steering wheel turns, the movement is carried through the torsion bar. The resistance of the front wheels causes the torsion bar to twist. This opens the control valve which sends pressurized fluid to one or the other side of the piston to provide the power assist.

Variable-Assist Power Steering

Some cars have a speed-sensitive, variable-assist power steering system. Additional parts include a power-steering controller (or ECM), steering-angle sensor, vehicle-speed sensor and solenoid valve. The steering-angle sensor measures the rate of steering wheel-rotation.

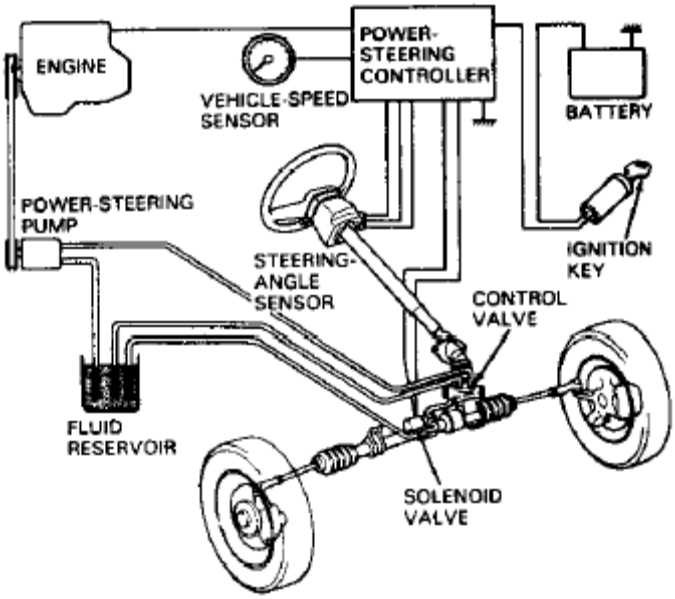


Figure 1-24 Variable-Assist Power Steering

This information and information from the vehicle-speed sensor are inputs to the controller. The controller determines the amount of power assist needed and sends the power signal to the solenoid valve. The solenoid valve then acts as an electronic variable orifice (EVO). It opens or restricts fluid flow to the steering gear. This varies the power assist, while providing the driver with the same steering feel.

Below about 20 mph (32 kmph), the solenoid valve allows full fluid-flow. This provides full power assist at low speed so only a light steering effort is required for parking. As vehicle speed increases, the solenoid valve reduces fluid-flow to the steering gear. This increases the steering effort and improves road feel. Full assist returns with sudden movement of the steering wheel.

Figure 36 shows the solenoid valve on the steering gear. Other systems have the solenoid valve in the power steering pump. On some cars, setting a switch on the controller increases or decreases steering effort by 10 percent. These cars also have a diagnostic connection from the power-steering controller. An analog voltmeter can receive trouble codes through the connector. The trouble codes indicate faults in the system.

Another speed-sensitive rack-and-pinion power-steering system is shown in Figure 33. The vehicle-speed sensor regulates the fluid pressure according to vehicle speed. A steering angle sensor is not used. Many rack-and-pinion and recirculating-ball power-steering systems have variable assist.

Electronic Rack-and-Pinion Power Steering

Some cars have an electronic rack-and-pinion power steering gear. A fast-acting electric motor inside the rack housing supplies the power assist. The pinion meshes with helical grooves which serve as the rack teeth. A magnet and magnetic sensor on the pinion shaft act as a torque sensor. It signals the electronic control module how much torque is being applied and in which direction.

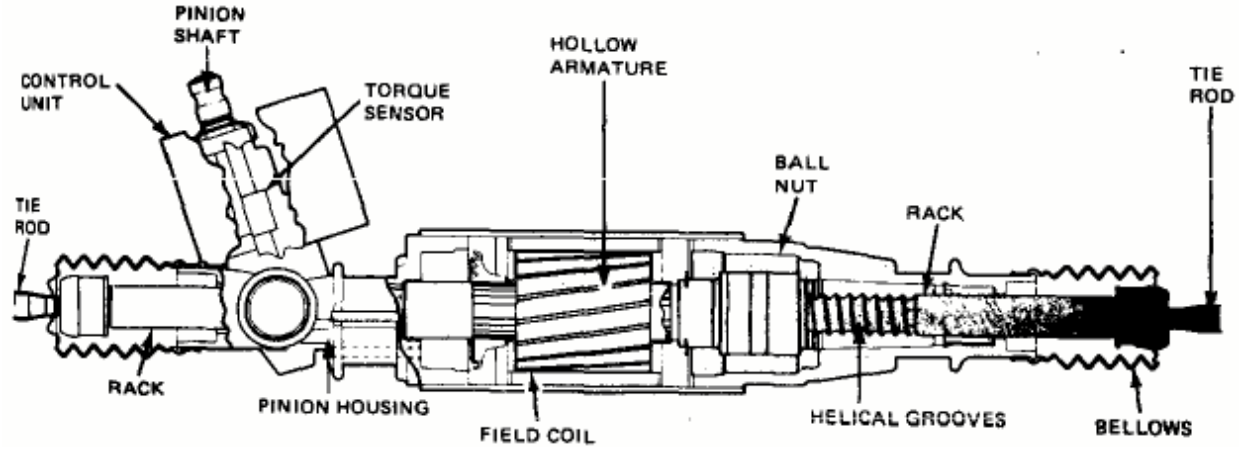


Figure 1-25 Electronic Rack-and-Pinion Power Steering

As torque is applied by turning the steering wheel, the magnet moves. The greater the torque and the farther the magnet moves, the stronger the signal to the ECM. The ECM then sends a varying current to the electric motor. The motor is splined to the ball nut. When the motor runs, the ball nut rotates. The rotation causes balls to run through the grooves in the rack. This applies a force against one end of the rack. The result is that most of the steering effort is supplied by the electric motor.

Electronic power steering does not require a hydraulic pump, hoses, a hydraulic pinion on the rack, or a sealed rack housing. In addition, if the driver prefers more or less power assist, it can be changed by resetting a selector switch.

Self-Check 1

Direction: Answer the following questions

1. The friction that is generated between a vehicle's tire and the road when the vehicle is in a non-skidding state is called _____ friction.

   A. static C. heat

   B. Kinetic D. Coefficient

2. Bleeding hydraulic system involves _____ from the system.

   A. removing water C. removing air pockets

   B. removing contaminated brake fluid D. filtering out dirt

   1. The purpose of the master cylinder is to _____.

3. What part of the system connects the steering wheel to the steering box wheels and tires?

   A. suspension C. power steering

   B. linkage D. electric motor

4. Which type of steering system uses only the driver's force to steer the vehicle?

   A. manual steering C. electronic steering

   B. power steering D. hydraulic steering

5. Which component of the steering system converts the rotary motion of the steering wheel into straight-line or linear motion?

   A. steering arm C. steering gear

   B. steering wheel D. steering knuckles

6. What component pivots inward or outward on ball joints?

   A. steering arm C. steering gear

   B. steering wheel D. steering knuckles

7. What component transmits the driver's movement to the steering gear?

   A. steering arm C. steering gear

   B. steering wheel D. steering knuckles

OPERATION SHEET 1:1

Objectives: Given an engine, ultraviolet light, special dye, paper and pencil and clean rags, you will perform leak test, record, analyze results and prescribe action.

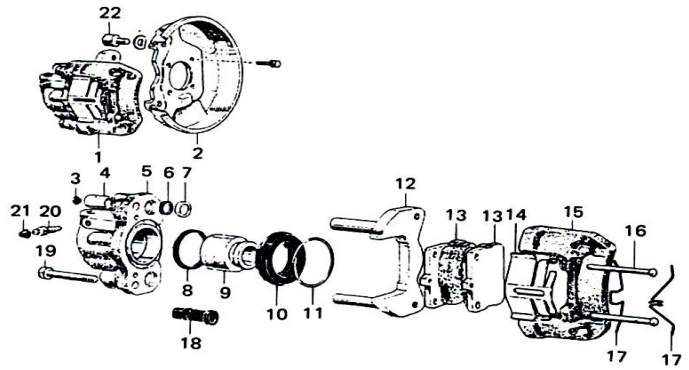
Instructions:

1. Prepare tools/equipment needed.
2. Wear protective clothing and goggles.

Objectives : Learning to disassemble and reassemble the disc brake.

Materials : Car (with disc brake), grease, brake fluid

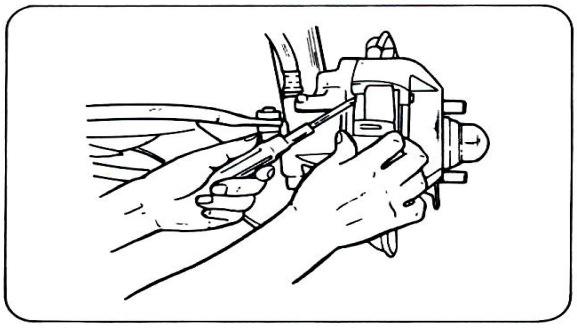
Equipment and tools : 1. Air gun 2. Torque wrench



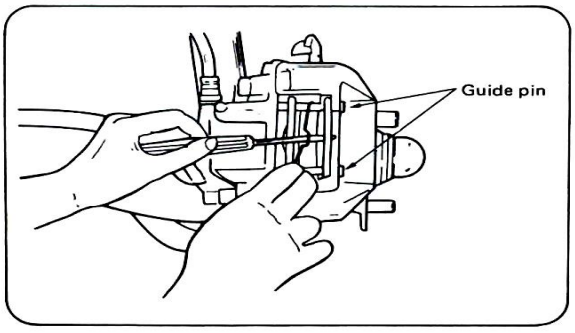
(1) Caliper assembly
(2) Disc brake cover assembly
(3) Hole plug
(4) Torque plate pin cap
(5) Cylinder body
(6) Dust seal
(7) Dust seal retainer
(8) Piston seal
(9) Piston
(10) Cylinder boot
(11) Ring
(12) Torque plate
(13) Pad
(14) Pad protector
(15) Outer body
(16) Guide pin
(17) Antirattle spring
(18) Torque plate pin bushing
(19) Bridge bolt
(20) Bleeder plug
(21) Bleeder plug cap
(22) Set bolt

[Disassembly]

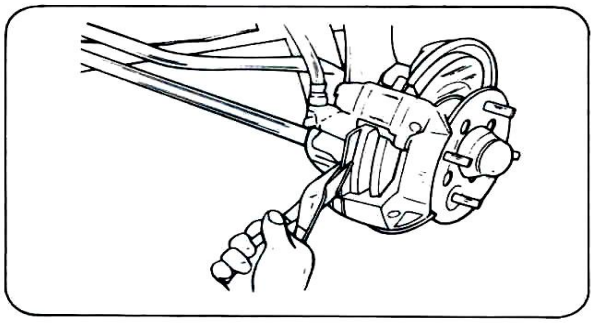
(1) Remove the disc pad.



(1) Remove the pad protector.



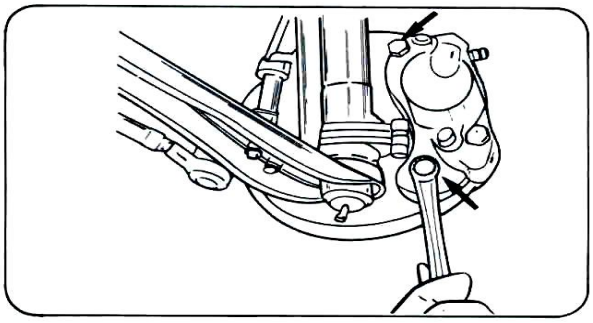
(2) Remove the antirattle spring.



(3) Remove the guide pin.

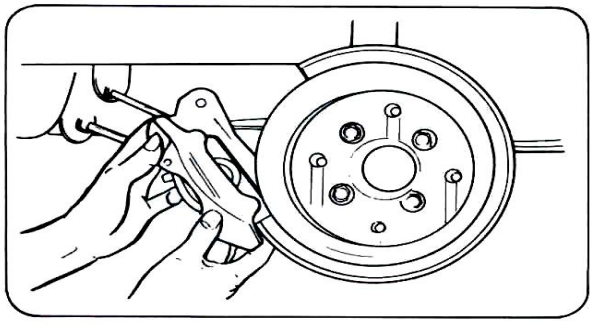
(4) Remove the disc pad.

2. Remove the caliper assembly.



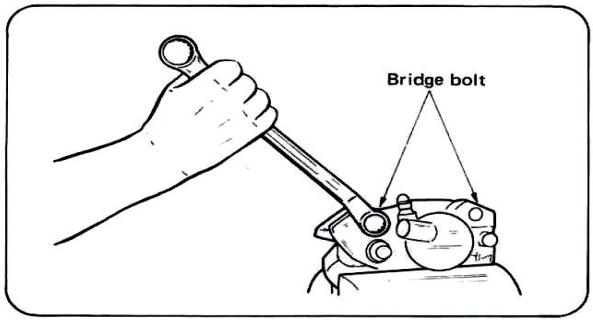
(1) Remove the brake hose.
a. Disconnect the brake pipe and brake hose beforehand.

(2) Remove the caliper mounting bolts.



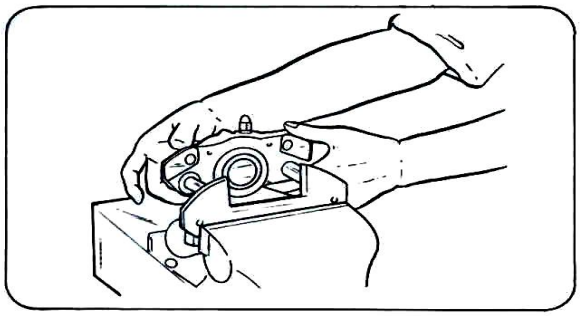
(3) Remove the caliper from the disc brake.

3. Disassemble the caliper.



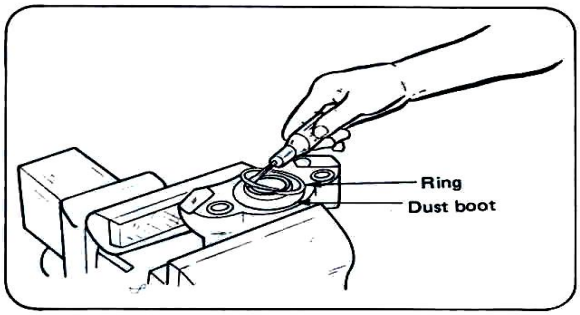
(1) Remove the bridge bolts.

(2) Remove the outer body from the cylinder.



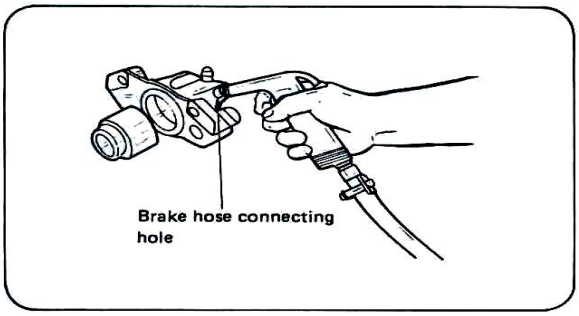
(3) Remove the torque plate from the cylinder body.

4. Disassemble the cylinder body.

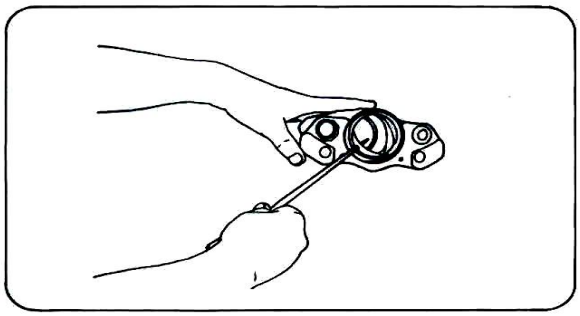


(1) Remove the ring.

(2) Remove the dust boot from the piston.



(3) Push out the piston.
a. Use compressed air.

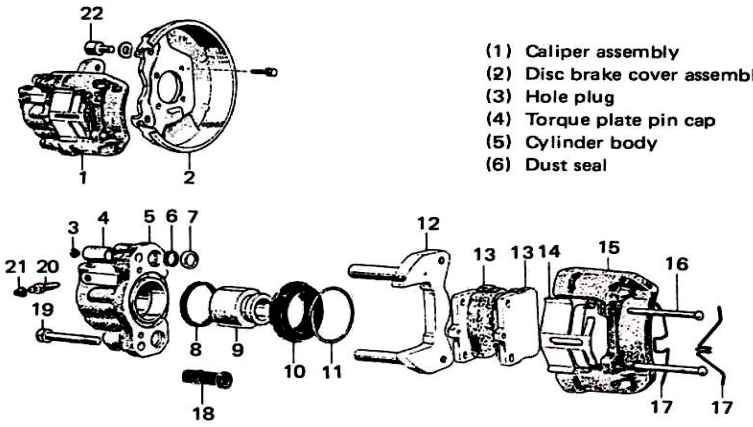


(4) Remove the piston seal.

Objectives : Learning to inspect the disc brake.

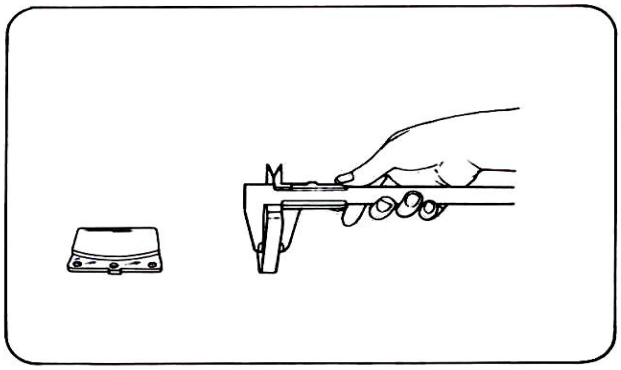
Materials : Car (with disc brake caliper assembly)

Equipment and tools : 1. Vernier calipers 2. Dial gauge (w/stand)



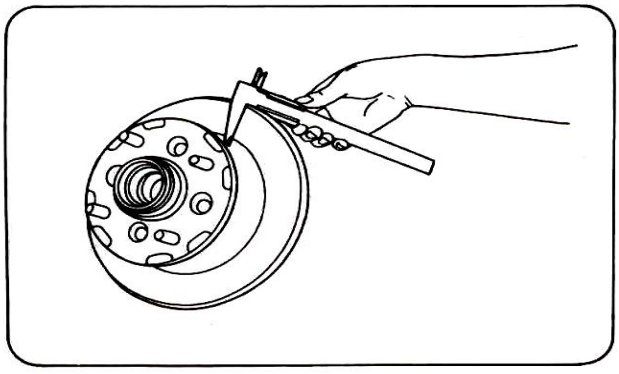
(1) Caliper assembly
(2) Disc brake cover assembly
(3) Hole plug
(4) Torque plate pin cap
(5) Cylinder body
(6) Dust seal
(7) Dust seal retainer
(8) Piston seal
(9) Piston
(10) Cylinder boot
(11) Ring
(12) Torque plate
(13) Pad
(14) Pad protector
(15) Outer body
(16) Guide pin
(17) Antirattle spring
(18) Torque plate pin bushing
(19) Bridge bolt
(20) Bleeder plug
(21) Bleeder plug cap
(22) Set bolt

1. Inspect the disc pad.

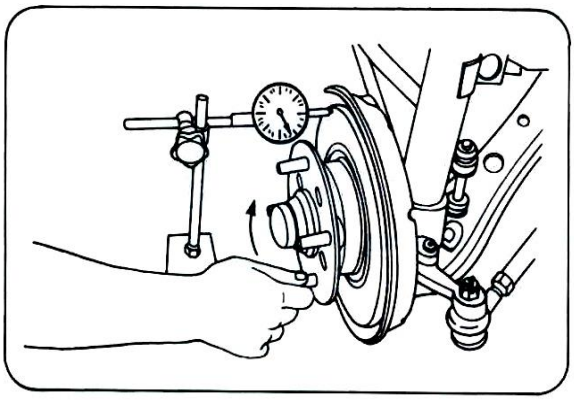


(1) Measure the thickness, and inspect for uneven wear or damage.

2. Inspect the disc.

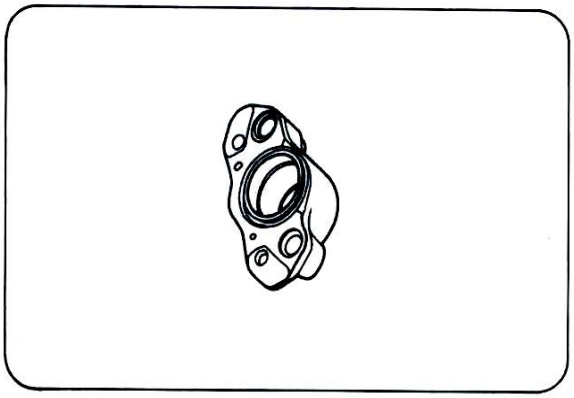


(1) Measure the thickness, and inspect for uneven wear or damage.



(2) Measure the runout, using the dial gauge.
a. Rotate the disc slowly.

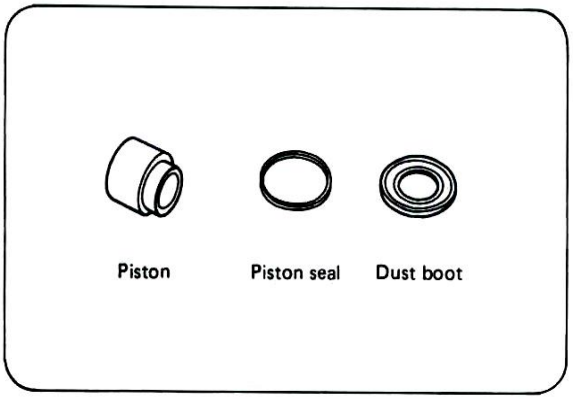
3. Inspect the cylinder body.



(1) Inspect for cracks or damage.

(2) Inspect the inside surface of the cylinder for uneven wear, damage or rust.

4. Inspect the piston and related parts.



(1) Inspect the piston for cracks, damage or rust.

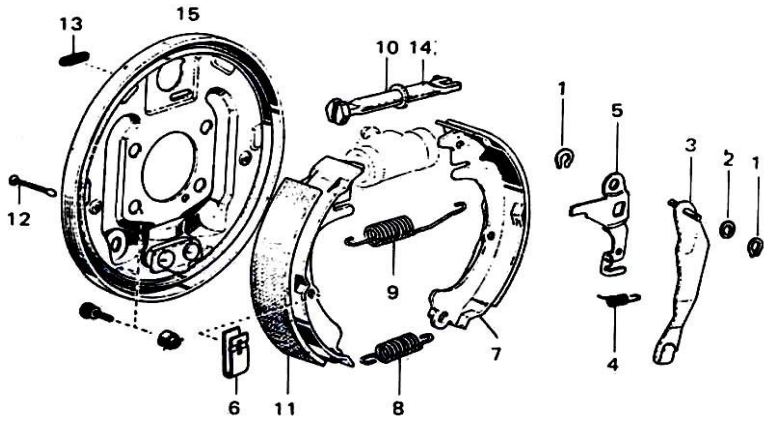
(2) Inspect the piston seal for wear or damage.

(3) Inspect the dust boot for damage or deformation.

Objectives : Learning to disassemble and reassemble the drum brake.

Materials : Car (auto adjuster equipped anchor pin type drum brake), grease

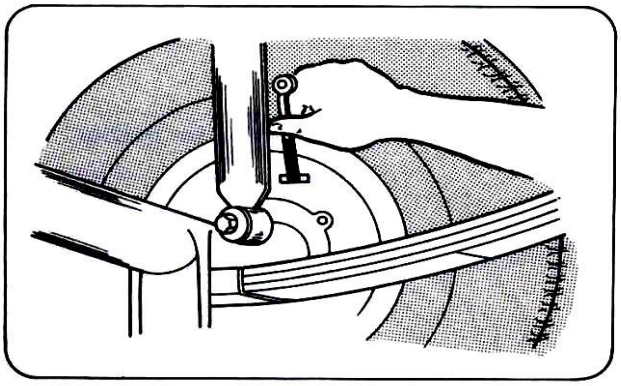
Equipment and tools : 1. Brake shoe return spring servicing tool



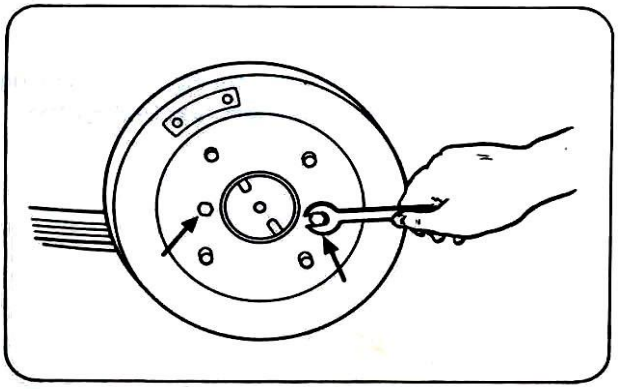
(1) C-washer
(2) Parking brake shoe lever shim
(3) Parking brake shoe lever
(4) Tension spring
(5) Automatic adjustment lever
(6) Shoe holddown spring
(7) Brake shoe
(8) Tension spring (for anchor)
(9) Tension spring
(10) Parking brake shoe strut set
(11) Brake shoe lining
(12) Shoe holddown spring pin
(13) Shoe adjusting hole plug
(14) Shoe support pin
(15) Brake backing plate

[Disassembly]

1. Remove the brake drum.

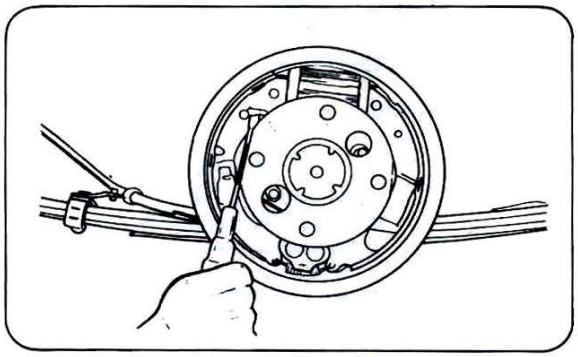


(1) If the drum is difficult to remove, perform the following operation first.
   a. Turn the brake adjuster to contract the brake shoe.

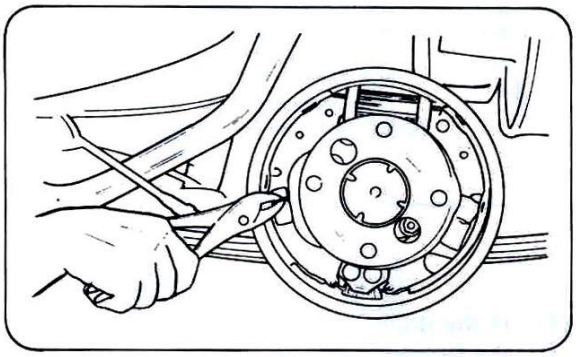


b. Screw bolts into two threaded holes on the drum to raise the drum from its mount.

2. Remove the front brake shoe.



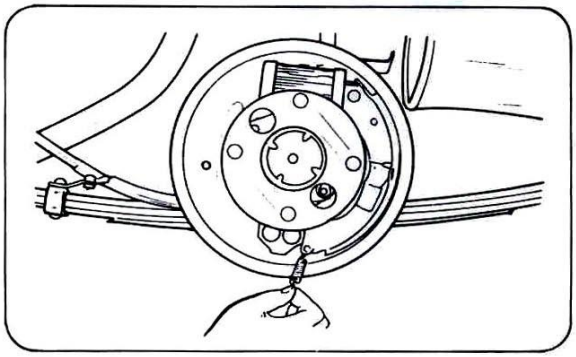
(1) Remove the tension spring.



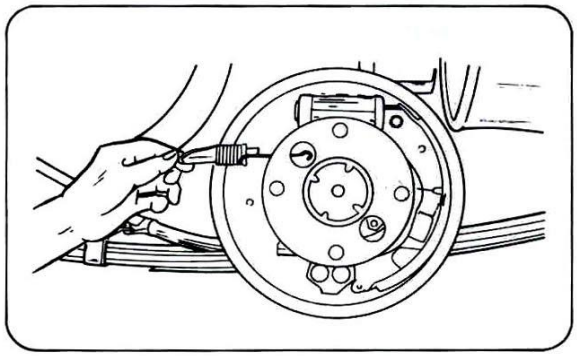
(2) Remove the shoe holddown spring and pin.

(3) Remove the brake shoe.
a. Do not get oil or grease on the shoe.

3. Remove each tension spring.

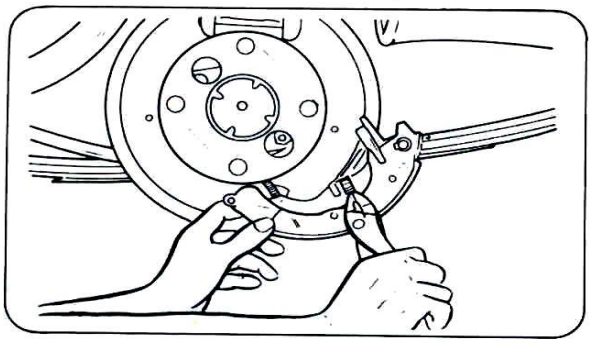


(1) Remove the tension spring for anchor.



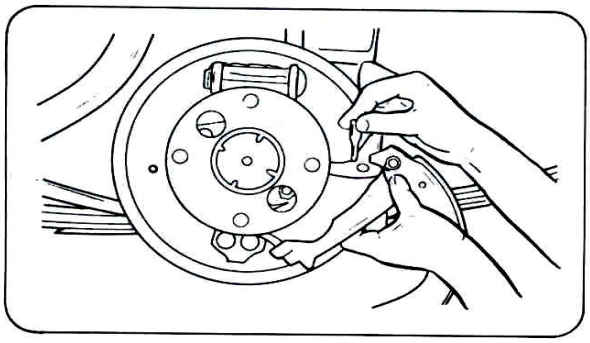
(2) Remove the tension spring and parking brake shoe strut from the rear brake shoe.

4. Remove the rear brake shoe.

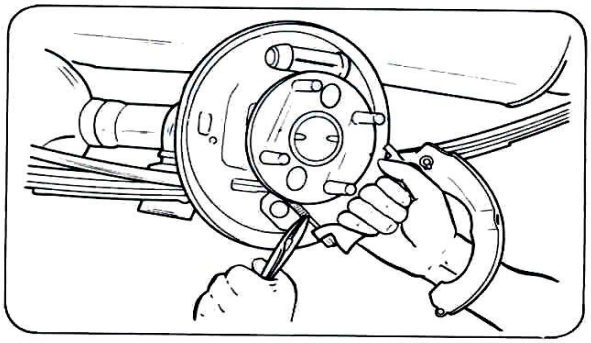


(1) Remove the shoe holddown spring and pin.

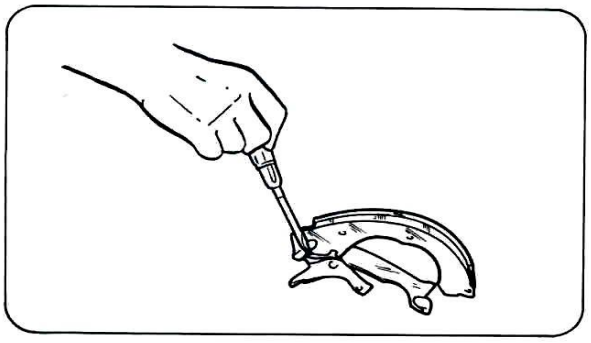
(2) Remove the tension spring for the auto adjuster.



(3) Remove the support pin from the parking brake lever.



(4) Remove the parking brake cable from the parking brake shoe lever.

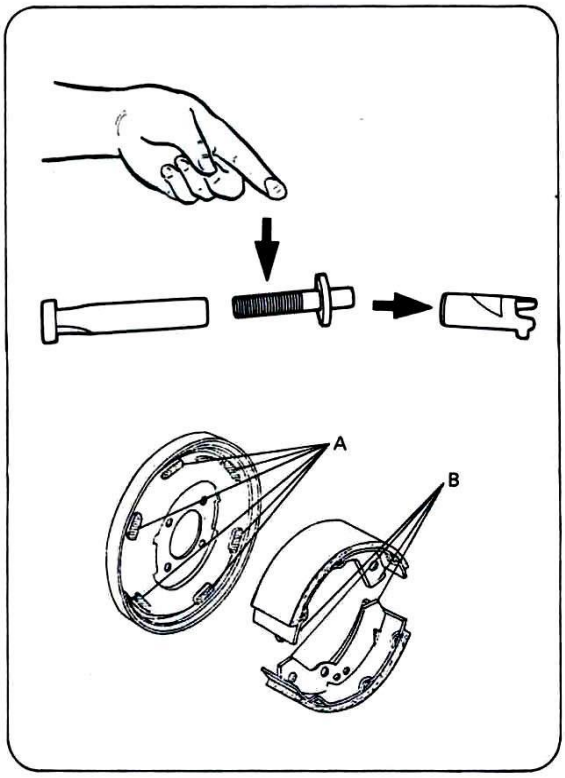


(5) Remove the following parts from the brake shoe.

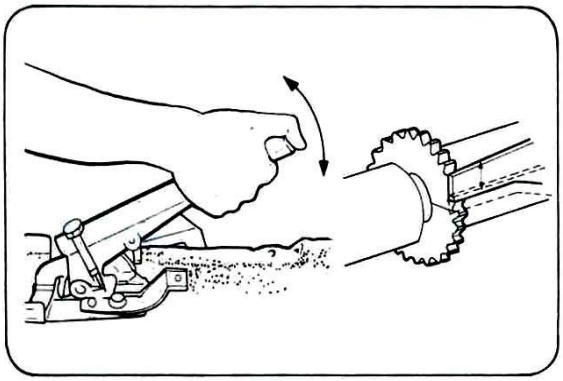
a. C-washer
b. Parking brake shoe lever
c. Automatic adjustment lever

[Reassembly]

5. Reassemble the brake.



(1) Pay attention to the following points:
   a. Ensure the proper position, direction and installing sequence of parts.
   b. Do not get oil or grease on the brake shoe or on the inner surface of the brake drum.
   c. Apply a thin coat of the specified grease to the threads of the parking brake shoe strut and to the hole in the support piece.
   d. Apply a thin coat of the specified grease to the backing plate-to-shoe contacting surface (A).
   e. Apply a thin coat of the specified grease to the wheel cylinder and to the anchor-to-shoe contacting surface (B).
   f. Replace the C-washer with a new one.



   g. Check the auto adjuster operation by moving the parking brake shoe lever.
   h. Ensure the smooth movement of the assembled parts.

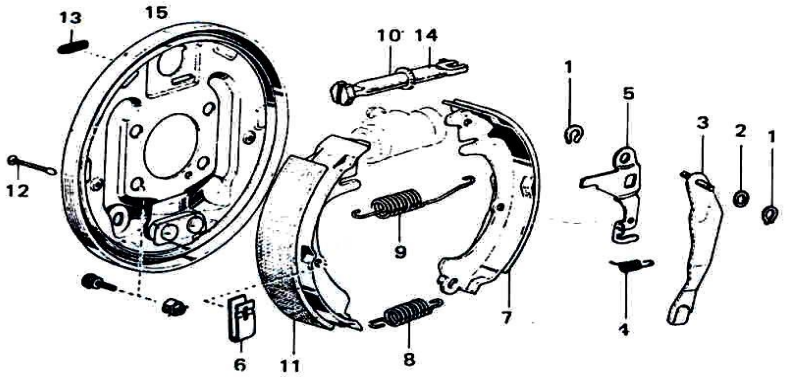
6. Adjust the brake shoe clearance.

(1) Follow the procedure described in "Adjustment of Brake Shoe Clearance."

Objectives : Learning to inspect the drum brake.

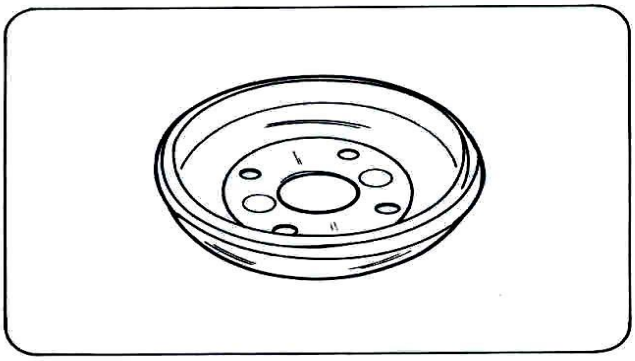
Materials : Car (with drum brake)

Equipment and tools : 1. Vernier calipers



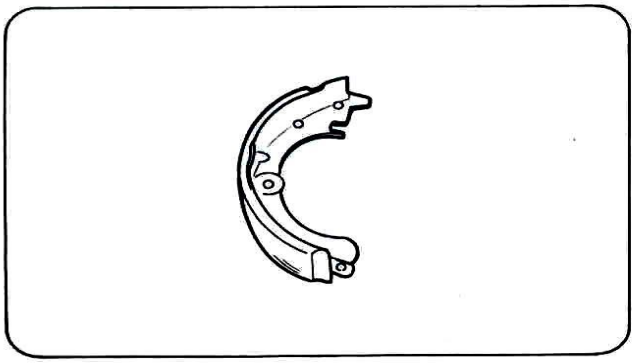
(1) C-washer
(2) Parking brake shoe lever shim
(3) Parking brake shoe lever
(4) Tension spring
(5) Automatic adjustment lever
(6) Shoe holddown spring
(7) Brake shoe
(8) Tension spring (for anchor)
(9) Tension spring
(10) Parking brake shoe strut set
(11) Brake shoe lining
(12) Shoe holddown spring pin adjusting hole plug
(14) Shoe support pin
(15) Brake backing plate

1. Inspect the brake drum.



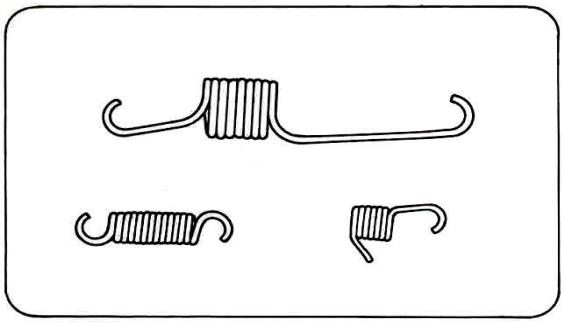
(1) Inspect for damage, excessive or spot wear on the inner surface.

2. Inspect the brake shoe.



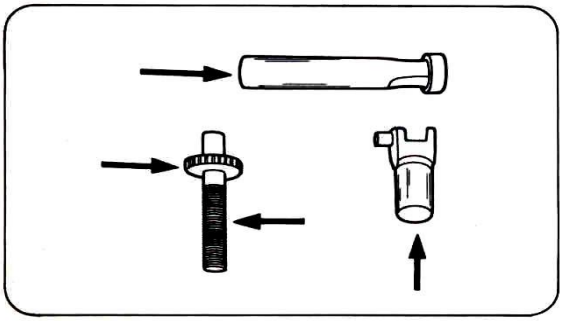
(1) Inspect the shoe for damage and the lining for excessive or spot wear.

3. Inspect the springs.



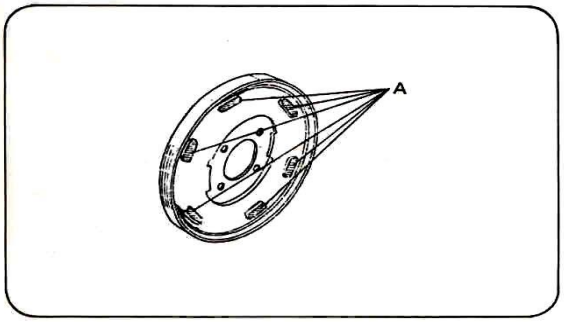
(1) Inspect for damage or deformation.

4. Inspect the brake auto adjuster.



(1) Inspect the tooth face of the parking brake shoe strut set and the bolt for wear, damage or improper movement.

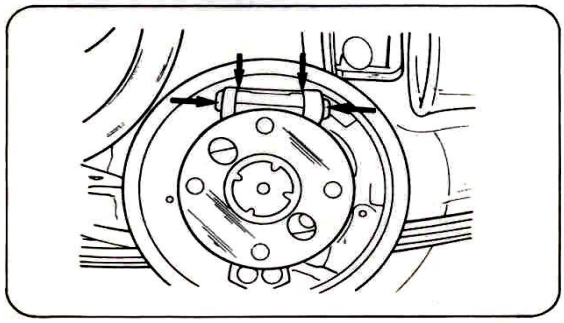
5. Inspect the backing plate.



(1) Inspect for damage.

(2) Inspect the shoe contacting surface (A) for wear or damage.

6. Inspect the wheel cylinder.



(1) Inspect for oil leaks.

Adjusting Brake Clearance to Specification

Check fluid level and refilling

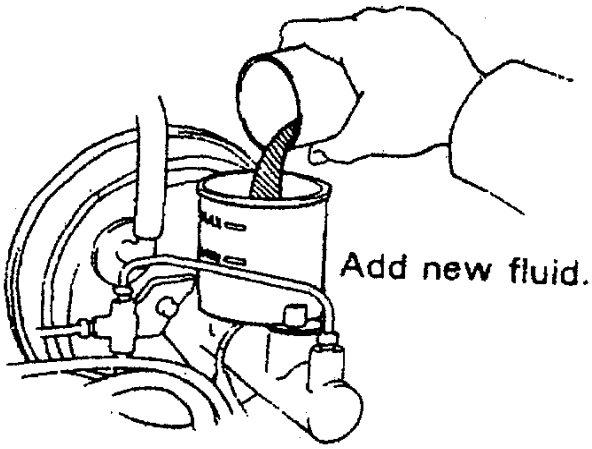
1. Check fluid level

   If Reservoir is plastic the level should be between max and min or 6mm for top or reservoir.

2. Add Fluid if necessary.

   Important:
   Do not let the reservoir run empty.
   Check the level frequently.

   Note: Do not allow fluid to scatter at any car parts especially on painted parts. Brake fluid will destroy your car parts.



Bleeding Hydraulic Brake (Manual)

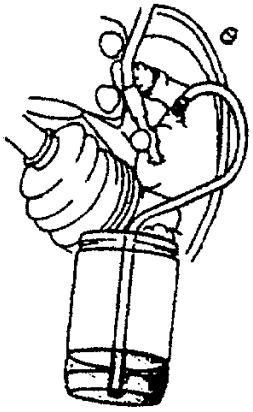
1. Raise the vehicle wheel.
   The wheel cylinder that is farthest from the master cylinder (Rear Right Wheel)

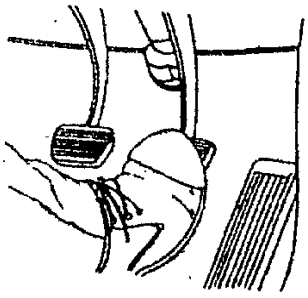
2. Remove bleeder plug cap from the bleeder screw or plug

3. Connect a Transparent hose to the bleeder plug and insert the other end in a half full container of fresh fluid.

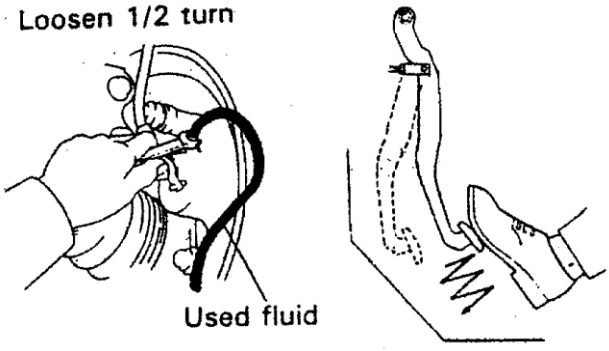
   Note: one end of the tube must be submerge in the fluid to prevent air from entering the system.

4. Pump the brake.
   Pedal several limes
   (this Is done by the assistant)





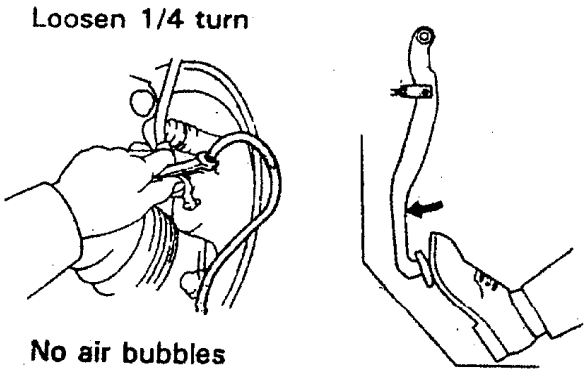
5. While tile pedal is depressed, loosen the bleeder plug about ½- turn to allow fluid to flow.



6. Keep on pumping the pedal until bubbles are drained

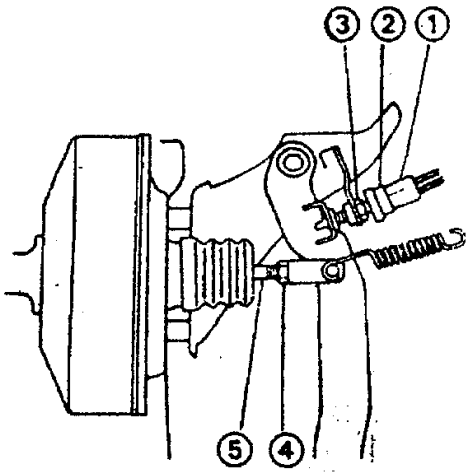
7. Add new fluid to reservoir

Important:
Do not let the reservoir run empty.
Check the level frequently

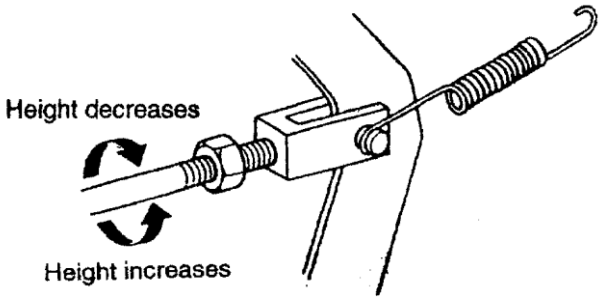


Adjusting Pedal free Travel (with booster)

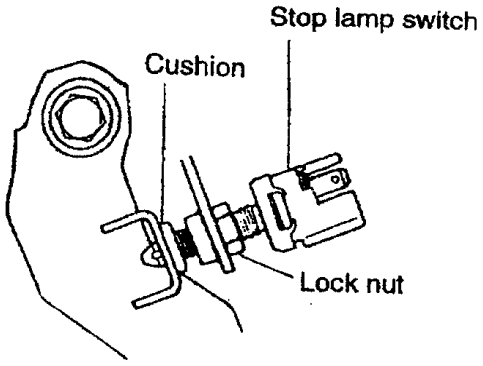
1. Disconnect wiring connector 1 for the stop light switch.
2. Loosen lock nut 3 of stop light switch and unscrew a few turn.
3. Loosen lock nut 4 of push rod
4. Adjust pedal height by turning the push rod



5. Screw in stop lamp switch until its pedal slopped lightly contact with the cushion tighten locknut.

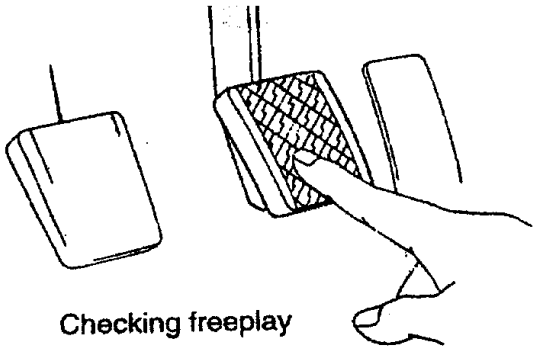


6. Be sure that the pedal stopper of the switch is not touching the cushion hardly, or the pedal height may be reduced.



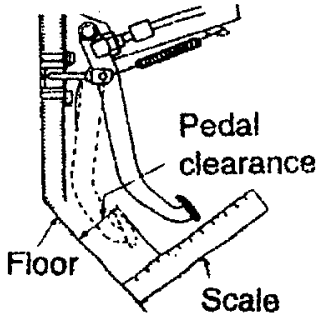
Properly contacting stopper
(Switch plunger is pushed in.)

7. Slightly push the brake pedal with your finger until it meets resistance

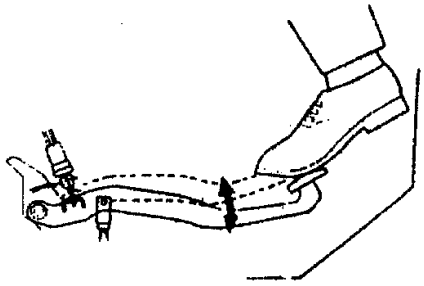


Checking freeplay

8. Measure pedal stroke refer to specification



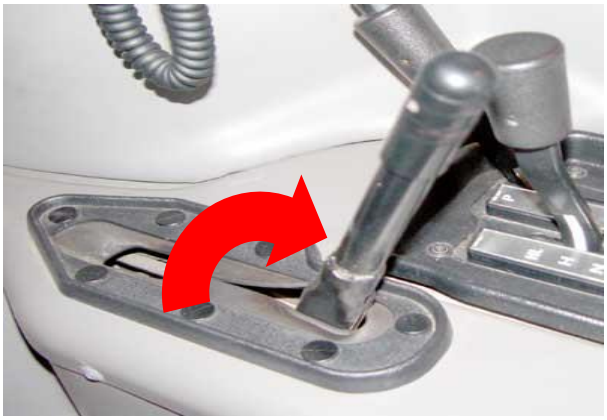
10. Tighten lock nut and measure again until pedal free play is correct



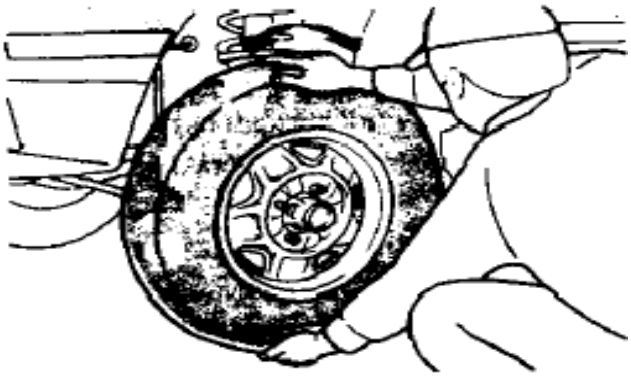
11. Start engine and confirm if free play is correct.

Emergency Brake/Parking Brake

1. Set parking brake to a fully applied position



2. Raise the car and make sure its wheels would not rotate. If the wheels rotate, proper adjustments must be made.



3. Release the parking brake, tighten adjustment lock nut and adjust the nut until tire cannot be rotated.
4. Stop tightening when you can no longer turn the wheels by hand.
5. Loosen the adjusting nut slightly until wheels turns with only a slight drag.
6. Check cables for fraying, breakage and deterioration
7. Spray all exposed metals with penetrating oils.
8. Clean off threaded areas and make sure the tightening nuts are not damage
9. Lower the vehicles and release parking brakes.

Lap Test-1

Instructions:

Given necessary templates, tools and materials you are required to perform the following Performing minor under chassis systems service.

Task 1. Inspect suspension system

Task 2. Inspect brake system.

Task 3. Adjust brake pedal free play.

Unit Two: Conduct basic inspection/test

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Common faults of under chassis systems
- Servicing techniques
- suspensions system/components
- power steering fluid
- steering system linkages

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Common faults of under chassis systems
- Identifying Servicing techniques
- Inspect suspensions system/components
- Checking power steering fluid
- Checking steering system linkages

2.1 Common faults of under chassis systems

- **Pulling to one side when driving**

If you notice your car is pulling to one side or the other while you're driving, the problem lies with your tires, your shock absorbers or your brakes.

Tires need to be precisely aligned (i.e. camber, caster and toe in) to ensure a smooth ride. Take a look at your tire treads to see if they are wearing evenly, and check that the tires are correctly inflated, as over- or under-inflated tires can impact your stability while driving.

- **Feeling every bump**

One of the main roles of the suspension system is to smooth out the bumps on the road. If you start to feel every bump on the road, it's a clear sign that there is a problem with your shock absorbers or struts that needs to be checked.

- **One corner sits low**

If you notice that one corner of your car seems to be a lot lower than the others, there's a good chance you have a worn or damaged spring. You may also notice a clunking noise as you drive over bumps or a deep pothole.

- **Difficulty when steering**

When your steering becomes difficult, especially when driving at low speeds, it means that there might be a problem with your suspension or steering systems. It could be a low level of power steering fluid, a faulty power steering pump, a leaking power steering rack or worn control arm bushings.

- **Oily shock absorbers**

Experts recommend doing a visual check of your suspension system at regular intervals. If you notice that your shock absorbers or struts look greasy or oily, there is a good chance they are leaking fluid. This means they won't be working optimally when you need them, so it's a good idea to have them checked by a mechanic.

2.2 Servicing techniques

Removing, refitting and adjusting components to ensure the vehicle system operates within specification is a summary of almost all the work you will be doing. The use, care, calibration and storage of test equipment are therefore very important. In this sense, 'test equipment' means:

- Measuring equipment, e.g. a micrometer
- Hand instruments, e.g. a spring balance
- Electrical meters, e.g. a digital MultiMate (DMM) (or an oscilloscope.

The operation and care of this equipment will vary with different types. Therefore, you should always read the manufacturer's instructions carefully before use, or if you have a problem. The following list sets out good general guidelines:

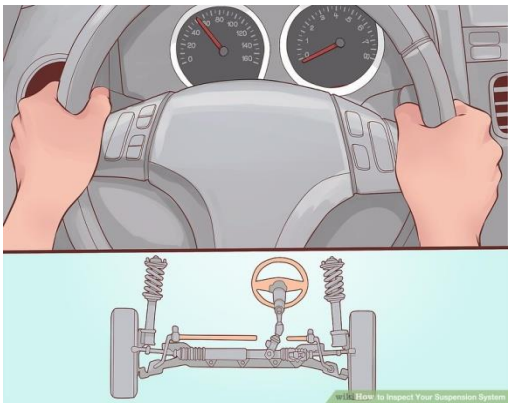
- Follow the manufacturer's instructions – at all times.
- Handle with care – do not drop keep the instrument in its box.
- Ensure regular calibration – check for accuracy.

2.3 Inspecting suspensions system/components

To minimize the chance of performing an unnecessary service, the following preliminary or general inspections should be made:

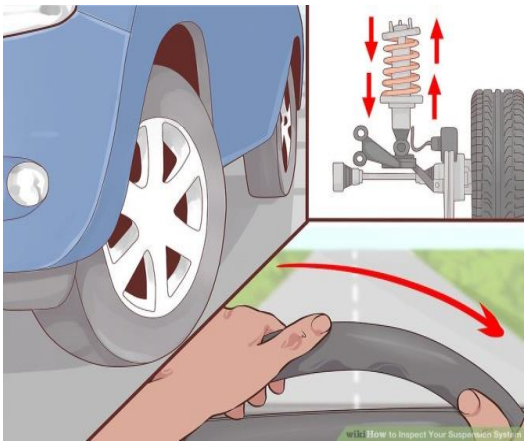
2.3.1 Identifying Signs of Suspension Issues

1. Pay attention if your ride begins to feel rougher



Over time, components of your suspension can wear out. While visually inspecting components can often let you know if they've become compromised, the easiest way to determine if you are having a suspension issue is by paying attention to how the ride in your vehicle feels. If it has become progressively rougher, it is likely because the suspension is no longer absorbing the bumps the way it is supposed to.

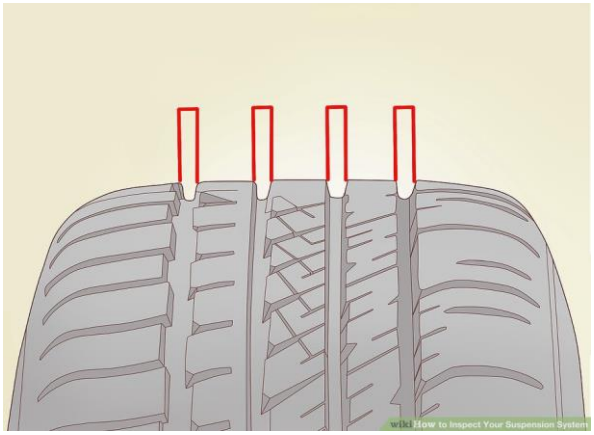
2.Take note if your vehicle pulls or squeaks during turns.



If you begin to feel as though the vehicle is working against you as you turn, it is likely the result of a failing suspension component. Different parts of your suspension can affect the steering response, angle of the tires, and the center of balance of the vehicle. Each of these elements can make your vehicle cumbersome or difficult to turn. A bad tie rod end will make steering response sluggish.

3. Inspect the tread wear on your tires.

Your tires should wear fairly evenly across the width of the tread. If you rotate your tires regularly, they should be worn close to evenly throughout. If you happen to notice the inside or outside of the tire is wearing at a faster rate than the rest, it could be an issue with the camber of your wheels and tires. Camber is the term used to describe the angle the wheel sits in relation to the vehicle and road.



4. Try braking abruptly to see if the nose dives as you stop.

If you are having issues with your front struts or shocks, your suspension may struggle to keep the vehicle level under hard braking. Stop quickly in a safe area and pay attention to the front of your car. If the nose of the vehicle dives or drops as you slow down, it may be as result of bad shocks or struts. If you can hear an audible clunk from the front of the vehicle as you brake, there is either an issue with your control arm or sub frame bushing.

5. Look to see if the vehicle sits level.

With the vehicle parked, walk around it and visually assess how level it seems to be sitting. If one side of the car rests higher than the other, there are likely worn out or broken suspension components to blame. It is not uncommon for the front of the vehicle to ride slightly lower than the rear in many vehicles such as pickup trucks, but the vehicle should otherwise be level.

2.3.2 Front Suspension inspection

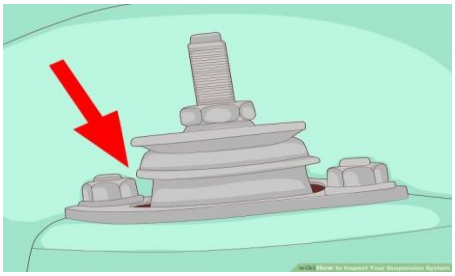
1. Pay attention to swaying and bouncing at low speeds.

Your vehicle should have no difficulty withstanding bumps in the road at low speeds. If you go over a bump and feel your vehicle sway back and forth or bounce after passing the bump, your suspension is struggling to support the weight of the vehicle.

- Your vehicle should be able to go over a bump and quickly regain composure at low speeds.
- If your vehicle sways back and forth after going over a bump, there is likely an issue with your suspension.

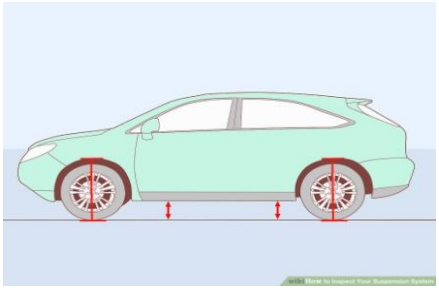
2. Visually inspect your strut mounts or shock towers.

Open the hood of your vehicle and look to either side. The struts or shock towers will extend through the fender above each wheel and be secured with one or a series of bolts or nuts. Look the fasteners over and ensure they are not covered in rust, and are not lose or otherwise compromised.



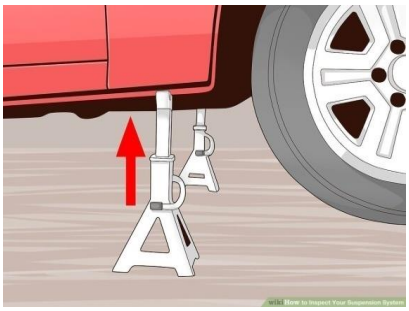
3. Measure the ride height on your front wheels.

Use a ruler or tape measure to determine the length of empty space between the top of the tire and the bottom of the fender well on the driver's side of your vehicle. Repeat the process on the passenger side and assess if there is a difference. While a slight variation is okay (a half inch or less) the two should be fairly equal.



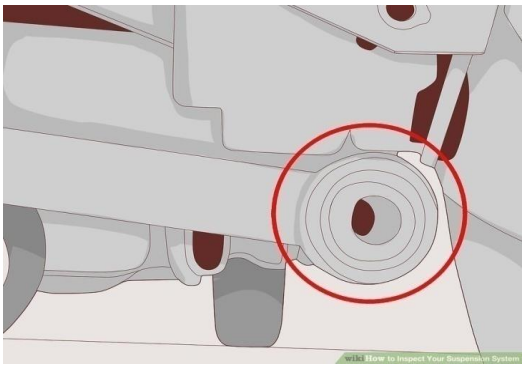
4. Jack up the vehicle.

You will need to get under the vehicle to visually inspect the condition of your suspension system. Place a trolley or scissor jack beneath the vehicle at one of its designated jack points for the front end.



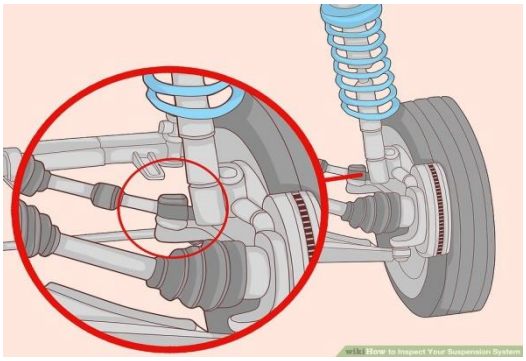
5. Visually inspect grease boots and rubber bushings for signs of damage.

Once you are beneath your vehicle, start at one wheel and look around at the rubber bushings separating metal components of your suspension from one another. They are usually black, though they may fade into grey over time. There may be as many as forty individual bushings between components of your suspension, though they are often round with a hole in the middle (like a doughnut).



6. Check for excess play in the tie rod ends.

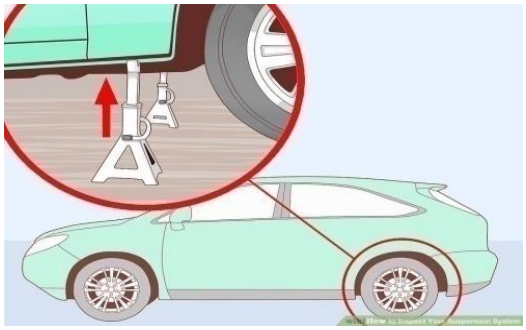
Locate the power steering box and follow its arms toward the wheels. If you are unsure where the power steering box is located in your vehicle, refer to the service manual specific to the year, make and model of your car or truck. Tie rod ends serve as the connection points between the steering box and the wheels, so if the bushings become compromised it could result in dead spots in your steering and reduced handling ability.



2.3.3 Inspecting Your Rear Suspension

1. Jack up the rear of the car.

Locate the rear jack points for your vehicle and place a jack beneath it. If the front of your vehicle is resting on jack stands, you may leave it in the air, but if you only have two jack stands you should lower the front end of the vehicle and use those stands to support the rear of it while you work.



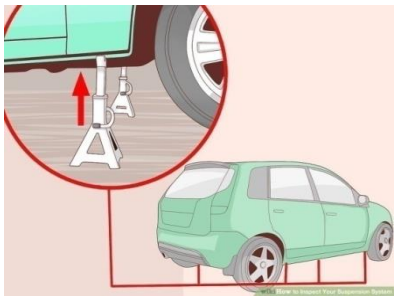
2. Wipe each joint clean and inspect the bushings for damage.

The rear suspension has far fewer components than the front, but they need to be inspected for the same signs of damage. It is likely that a lot of mud and debris has gotten trapped by the rear suspension, so you may need to wipe the bushings off with some water and a rag to be able to properly inspect them.

3. **Inspect bolts and nuts for rust and tightness**. Check the nuts and bolts used to secure components of the suspension to one another and the vehicle for signs of excessive rust and to make sure they are tight. Use a screw driver to poke at the fastening hardware that appears rusty. If bits of the rusted nut or bolt comes off as you poke at it, the hardware will need to be replaced.

4. **Inspect one wheel at a time with an independent rear suspension.**

If your vehicle came equipped with an independent rear suspension, you will need to jack up each side of the vehicle to inspect the suspension on that side. Although you may not need to with some vehicle, you should anticipate needing to remove the wheel and tire in order to access and inspect the suspension components.



2.3.4 Conducting a Bounce Test

1. **Park your vehicle on firm, even ground.**

In order to conduct a bounce test you need to remove any variables that could affect how the vehicle recovers from being bounced. Soft or uneven ground can affect how the vehicle sits, giving you a less reliable outcome.

- Blacktop or concrete are the preferred surfaces to conduct this test on.
- An uneven surface will shift the weight of the vehicle, causing the suspension to respond differently than it would otherwise.

2. **Push down firmly on the front of the vehicle.**

The bounce test requires that you compress the suspension of the vehicle and assess how it recovers. In order to do so,

Place both of your palms on a stable part of the front of the vehicle (the hood will suffice) and press down with all of your weight. Take your hands away and watch the vehicle as it rises again.

Press on the hood near the very front of the car to prevent putting a dent in it. If you are unable to put enough pressure on the vehicle to compress the suspension, ask a friend to help.

3. **Count how many bounces the suspension needs to recover.**

After releasing the vehicle, it should bounce back up and right itself in a single bounce. If it bounces a few more times as it settles, the shock absorbers in the front of your vehicle are likely bad. Even if you push down on the hood several times before releasing it, it should still right itself with only one bounce.

2.4 Check power steering fluid

Checking power steering fluid is a simple task anyone can do. Yet, it's often overlooked until the signs of low power steering fluid emerge, such as the pump whining and making noise. In this post, we'll explain how to check power steering fluid and how to change it.

First, check your owner's manual for recommendations on how often to check power steering fluid. Since it's so simple, check power steering fluid anytime I check my oil level or before long trips.

1. **Locate the Power Steering Fluid Reservoir**

Its location differs for every vehicle. It's usually a small, clear container with a black cap. Many vehicles have marks on the outside of the reservoir to indicate "MAX" or "MIN." Ensure the fluid level is above the "MIN" mark but not overfilled.

2. **Check Dipstick (If Equipped)**

Other vehicles have marks on the dipstick, similar to an oil dipstick. In this case, remove the cap and wipe the dipstick clean. Reinstall the cap, ensuring it's completely seated.

3. **Remove Cap Again and Check Fluid Level)**

Ensure it's at the appropriate level. You may see marks for "full hot" and "full cold," so ensure you're referencing the correct mark depending on whether the engine is hot or cold.

4. **Add Power Steering Fluid**

Top-off the reservoir if needed to fill to the appropriate level.

2.5 Checking steering system linkages

- **Flexible steering joint**

✓ Rag joint: Check the flexible coupling connecting the steering shaft to the steering gear. Replace if damaged or deteriorated.

✓ Flexible joint: Inspect and replace if the joint binds, is excessively loose or show signs of rust.

- **Idler arm**

✓ Check for damaged attachment points, bends and twists.

✓ Check for ball joint and bushing wear.

- **Outer tie rods**

✓ Steer the wheels back and forth checking for looseness of the ball joint stud.

✓ Depress the tie rod ball joint and check for excessive up and down play. Replace the tie rod if any movement is detected.

✓ Twist the tie rod by hand. The tie rod should rotate through its entire operating range without binding. Replace the tie rod if it will not rotate freely.

✓ Inspect protective rubber boot for damage. Torn or damaged boots will allow dirt to enter the socket area and destroy the socket.

✓ Inspect the adjustment sleeve. Replace the sleeve if bent or damaged.

Pitman arm

- Check for tight fit to steering gear or sector shaft.
- Check for bends or twists and ball joint wear.

Power steering systems

Check the pump, belt and hoses for leaks, damage or signs of wear or deterioration.

Rack and pinion style inner tie rods

✓ Rock the steering wheel side to side. A worn inner socket will allow the tie rod to move in and out independent of the rack gear.

✓ Replace bellows boots that are torn, cracked or softened from steering fluid.

✓ Check for bent rods, and damaged or worn ball joints.

Spindle

✓ Inspect ABS plug for damage. ABS wire must remain secured to spindle. Inspect for scored bearing race areas.

✓ Do not use spindles that have corrosion on areas where seals or bearings contact. Inspect for obvious distortion.

Steering arm

- ✓ Measure the distance from the brake rotor to the ball joint. Compare this measurement from one side of the vehicle to the other. The measurements should be equal. Unequal measurements indicate a bent steering arm.
- ✓ In addition, the steering arm should be measured to a symmetrical location on the upper or lower control arm. This measurement checks for vertical movement in the steering arm.

Steering column

- ✓ Check mounting points for damage.
- ✓ Rock the steering wheel from side to side and up and down to check for any wobble or abnormal steering effort or noise. If there is excessive movement or an audible clunking or grinding sound, replace the steering column.
- ✓ Inspect for obvious compression of the column jacket.

Steering center link

- ✓ Have an assistant steer the front wheels back and forth and observe the center link joints. Any looseness is not acceptable.
- ✓ Check for signs of impact or bends.

Steering knuckle

- ✓ Place a straight edge vertically on the brake rotor. Measure from the straight edge to several points on the steering knuckle. Compare these measurements from one side of the vehicle to the other. The measurements should be equal. Unequal measurements indicate a bent steering knuckle.
- ✓ Check for signs of flaking coatings or corrosion on the knuckle. When a cast part is bent it may disturb and loosen any coatings or corrosion that has built up on the part if the degree of bend is severe enough.
- ✓ Discard any knuckle that shows signs of previous repair by heating, welding or straightening.
- ✓ Check knuckle for cracks, twisted ears and damaged attachment points such as elongated holes.

Steering linkage

- ✓ Vehicle on ground

  Have an assistant rock the steering wheel while checking the steering linkage for any side-to-side (lateral) looseness.

- ✓ Vehicle weight off front tires

  – Steer each front wheel by hand to identify components with excessive lateral movement.

  – Rotate steering linkage components by hand to check for binding of ball joints and excessive up and down (vertical) movement.

Steering wheel

Check for a cracked or bent wheel and damage resulting from air bag deployment.

Self-check 2

1. The core of any suspension system is the _____.

A .wheel spindle assembly C. ball joints

B. spring D. control arm

2. What occurs when a wheel hits a dip or hole and moves downward?

A. jounce C. deflection

B. free length D. rebound

3. Which of the following is part of the sprung weight of the vehicle?

A. steering linkage C. engine

B. tires D. all of the above

4. What occurs when a wheel hits a dip or hole and moves upward?

A. jounce C. deflection

B. free length D. rebound

5. The coil springs of the vehicle _____.

A. support the weight of the vehicle C. stabilize the up-and-down motion

B. provide axle location D. all of the above.

6. Before replacing springs, vehicle height is checked on both sides of the front suspension, and tire pressure is checked. Should you check the amount of fuel in the vehicle?

A. Yes, the fuel tank should be empty. C. No, it does not make any difference.

B. Yes, the fuel tank should be full. D. None of the above.

8. Coil spring are used _____.

A. on all strut suspensions D. only on modified MacPherson suspensions

B. on selected strut suspensions

C. not at all on strut suspensions

9. When the wide bottom of a control arm is toward the front of the car and the point turns in to meet the upright, it is called a (n) _____.

A. trailing arm C. wishbone arm

B. semi trailing arm D. A-shaped arm

10. The modified MacPherson strut rear suspension is very common in _____.

A. front-wheel-drive vehicles B. rear-wheel-drive vehicles

C. pickup trucks D. station wagons

Operation sheet 2:1

Objectives: Given an engine, ultraviolet light, special dye, paper and pencil and clean rags, you will perform leak test, record, analyze results and prescribe action.

Instructions

It will be necessary to bleed the fuel system to achieve a steady air free flow of fuel if any of the following have occurred.

1. Check all tires proper inflation pressures
2. Check the tires for telltale indications of improper front-end alignment, wheel and tire imbalance, and physical deflect or damage.
3. Check the vehicle for optional suspension equipment, such as that provided for heavy-duty applications or trailer towing packages. They have a firmer ride quality.
4. Check vehicle attitude for evidence of overloading or sagging. Be sure the chassis height is correct.
5. Raise the vehicle off the floor. Grasp the upper and lower surfaces of the tire and shake each front wheel to check for worn wheel bearings.
6. Check all the ball joints for looseness and wear.
7. Check the condition of the struts' upper mounts.
8. Check the shock absorbers and strut for signs or fluid leakage and damage.
9. Check all the mountings for the shocks and struts.
10. Check all suspension bushings for looseness, splits, cracks, misplacement, and noises.
11. Check the steering mounts, linkages, and all connections for looseness, binding, or damage.

If any problems or unusual conditions are found during the visual inspection, the parts should be replace

Lap Test-1

Instructions: Given necessary templates, tools and materials you are required to perform the following Performing minor under chassis systems service.

Task 1. Removing and Assemble leaf spring

Task 2 Check steering system component

Task 3. Front Suspension inspection

Unit Three: Carry out minor repair

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Remove and replace suspensions system/components
- Remove and adjust steering system components
- Remove and replace hydraulic brake system/components
- Adjustment techniques on under chassis system

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Removing and replacing suspensions system/components
- Removing replacing and adjusting steering system components
- Removing and replacing hydraulic brake system/components
- Applying different adjustment techniques on under chassis system

3.1 Remove and replace suspensions system/components

The purpose of an inspection is to determine the cause for the vehicle owner's complaint and to determine what steps will be needed to cure the complaint. It is a god practice to note any other parts that show signs of failing in the near future so the customer ca be aware of them. The suspension should operate for many miles and a year or so until the next time it is inspected; the average motorist does not check suspension components very frequently.

Sometimes an inspection will determine that a simple adjustment or realignment is all that is needed to correct the situation; often a worn bushing or ball joint will show up. Worn parts must be replaced before an alignment can be done. It does no good to do a wheel alignment if the suspension parts are sloppy. In most cases on an older car, when realignment is necessary, that need is probably caused by worn parts or sagged springs. Remember that the rear wheels also have a suspension system and that their parts also wear out. Rear suspension bushings and pivots are checked in the same manner as those at the front.

As an inspection is being performed, it is a good practice to follow a set procedure to ensure that portions of the suspension and steering systems are not skipped or forgotten. When checking a modern car, another good practice is to note the instrument panel lights as you start the engine. They will indicate if the car has ABS or an airbag and if these systems are operating properly.

A suspension and steering system inspection should include checks of the:

1) Steering wheel for excessive steering looseness or binding.
2) Tires for correct inflation.
3) Tires for wear pattern to give an indication of incorrect alignment, balance, or worn parts, and also for physical defects that might cause failure.
4) Vehicle for correct height and attitude.
5) Vehicle for optional springs, shock absorbers, or overload devices that might change the ride quality or alignment.
6) Tire spinning (by hand) for tire runout and wheel bearing condition.
7) Tire and wheel shake (top and bottom) for wheel bearing looseness.
8) Tire and wheel shake (side to side) for steering component looseness.
9) Ball joints for excessive looseness, boot condition, and binding.
10) Control arm bushings and end links for wear or deterioration.
11) Strut rod bushings for wear deterioration.

12) Stabilizer bar bushings and end links for wear or deterioration.

13) Springs for loose or broken parts.

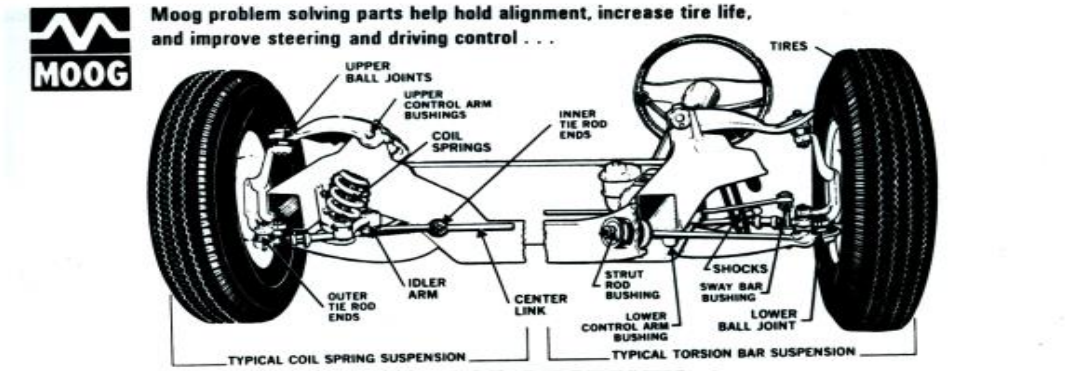
14) Shock absorbers or strut for leakage, loosen or broken mounts or broken parts.

15) Tie rods for looseness or torn boots.

Many technicians follow an inspection checklist. The checklist helps ensure that none of the checks is missed or forgotten, and it allows a more professional discussion with the car owner.

3.1.1 Spring and shock absorber Inspection

An inspection of the springs and the shock absorbers often begins with a customer complaint of noise, tire wear low vehicle (one end, one side or all over, excessive vehicle leaning on turns, or front end dive under braking. Any of these complaints might indicate weak or broken springs or shock absorbers.



YOUR CAR DESERVES A

WHEEL TO WHEEL SECURITY CHECK

Owner _____ Date _____ Phone _____

Make _____ Model _____ Year _____

Mileage _____ License Number _____ Engine Size _____

PARTS DESCRIPTION	OK	COMMENTS	PARTS	LABOR
SPRINGS				
CONTROL ARM BUSHINGS				
POWER STEERING				
LOWER BALL JOINT				
UPPER BALL JOINT				
WHEEL BRGS.				
BALANCE				
TIRES				
TIE ROD ENDS				
IDLER ARM				
PITMAN ARM				
CENTER LINK				
SWAY BAR BUSHINGS				
STRUT ROD BUSHINGS				
SHOCK ABSORBERS				
ALIGNMENT				
REMOVED PARTS REQUESTED	YES		SUB TOTAL	
	NO			
			TOTAL	

Inspector

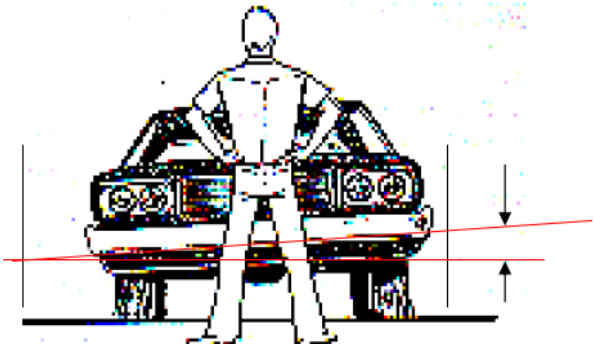
FORM 2000C • Litho in U.S.A.

CAR HEIGHT			
	Left	Right	Specs.
FRONT			
REAR			
BALL JOINT READINGS			
Load Carrier	Left	Right	Specs.
AXIAL			
RADIAL			
ALIGNMENT			
	Left	Right	Specs.
CAMBER			
CASTER			
TOE			

REMARKS:

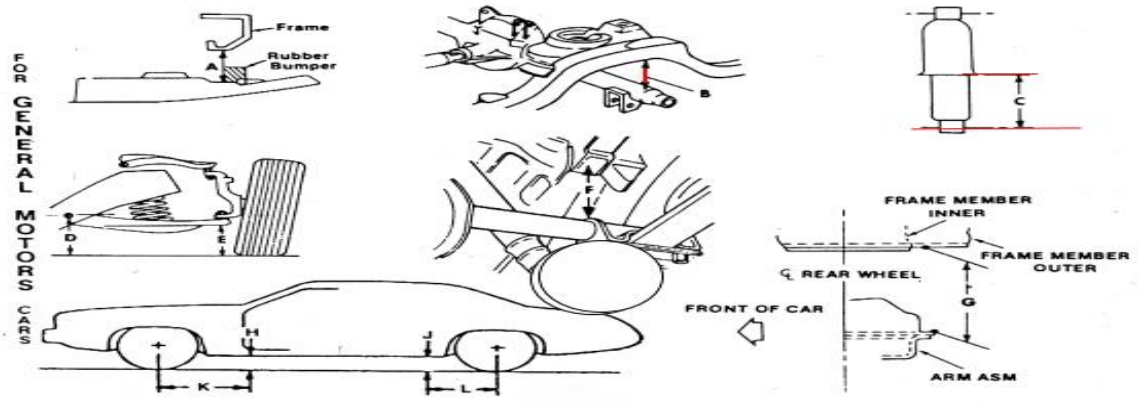
3.1.2 Check Suspension Ride Height

1. Park the car on a smooth level surface; the ramps of a wheel alignment rack are ideal because they are level and allow easy access to the suspension members.
2. Check for unusual amounts of weight that might be in the trunk or backseat of the car. You should be removed or allowances made for any added weight; ride height specifications are given for unloaded cars.
3. Check the tire pressure and correct it, if necessary. Note whether the tires are stock size; if not, allowances must be made in the checking dimensions.
4. Obtain the ride height specifications and the locations of the measuring points.
5. Measure the distances at each measuring point and compare them with the specifications. Sagged springs are indicated if the measured distances are shorter or lower than the specifications.
6. Compare the left and right measurements; they should be almost equal.



This vehicle is probably leaning because of a weak right front or rear spring; Lifting the car in the exact center at the front or rear will usually show if it is the front or the rear spring that has sagged.

When one side of the car sags more than the other, it is necessary to determine whether the lean is caused by a weak front spring, a weak rear spring, or both; either will cause this problem.



"A" Dim. — Vertical distance from top of front lower control arm in front of rubber strike-out bumper, to undersides of frame.
"B" Dim. — Vertical distance from top of rear axle housing to underside of frame side member.
"C" Dim. — Vertical distance from lower edge of front shock absorber dust shield to centerline of lower attachment stud.
"D" Dim. — Vertical distance from ground to centerline of front bushing bolt head.
"E" Dim. — Vertical distance from ground to underside of ball joint cover plate in board of and adjacent to lube fitting.
"F" Dim. — Vertical distance from top of rear axle housing to underside of bump stop bracket adjacent to rubber bumper.
"G" Dim. — Vertical distance from top of control arm flange, adjacent to shock absorber, to underside of frame outer side rail.
"H" Dim. — Ground to rocker panel at front.
"J" Dim. — Ground to rocker panel at rear.
"K" Dim. — Front wheel centerline to "H".
"L" Dim. — Rear wheel centerline to "J".

3.1.3 Check a kingpin for excessive clearance

1. Raise and support the vehicle on a hoist or jack stands.

2. Eliminate wheel bearing clearance by installing a brake pedal jack to apply the brakes or by tightening the spindle nut.

3. Position a dial indicator at the lower part of the tire with the dial indicator stylus in a horizontal position.

4. Push in and out on the tire while observing the dial indicator readings. Worn kingpins are indicated if there is more than:

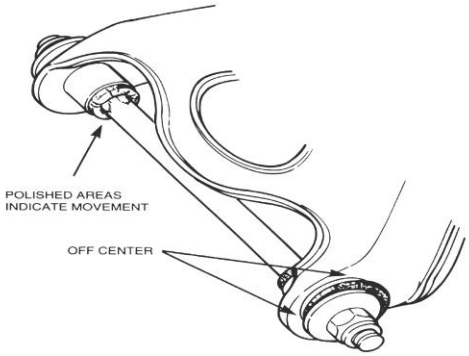
a. ¼ or 0.250 inch (6.35 mm) of side motion on 16 inch or smaller wheels.

b. 3/8 or 0.375 inch (9.5 mm) for 17 inch to 18 inch wheels.

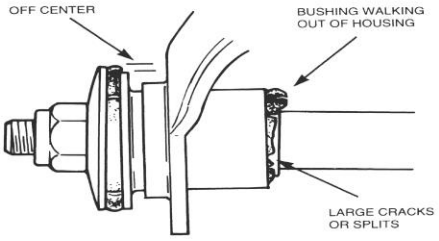
c. ½ or 0.500 inch (12.7 mm) for wheels larger than 18 inch.

3.1.4 Check Control Arm Bushings

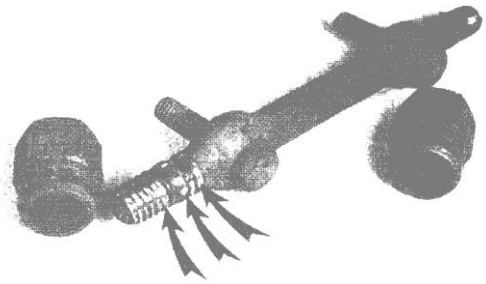
Worn suspension bushing allows the control arm to move inward and outward or forward and backward as well as up and down. This results in an alignment change of the tires which in turn, will cause tire wear and handling difficulties. This looseness often causes suspension noises, usually “clunks” when driving over rough roads or when the brakes are applied.



Faulty rubber control arm bushings can usually be seen during a visual inspection. In locations where the bushings are difficult to see, faulty bushings are identified by excessive control arm motion through either an in-and-out or a sideways direction.



To check rubber control arm bushings, you should:



1. If possible, check the upper control arm bushings from under the hood. Use a light so you can get a good look at the rubber parts of the bushing. Ignore small, light cracks as long as the rubber is still solid and resilient. Look for

heavy cracks, rubber material breaking out, or rubber distortion, which allows the control arm to change position.

The pivot bolt should be centered in the bushing. Bushings that are distorted, breaking up, or getting ready to break up should be replaced.

2. Raise and support the car on a hoist or jack stands.

3. Visually check the bushings on the lower control arm, looking for the same sort of problems Also, check the sides of the control arm and the frame metal next to it for signs of metal contact, which indicate bushing failure.

5. On single lower control arms, try prying the inner end of the control arm sideways using a pry bar or large screwdriver. A slight motion is acceptable; larger motions indicate weak bushings.

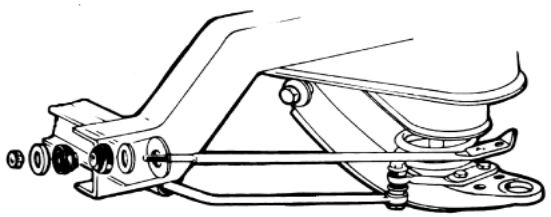
To check metal control arm bushings, you should:

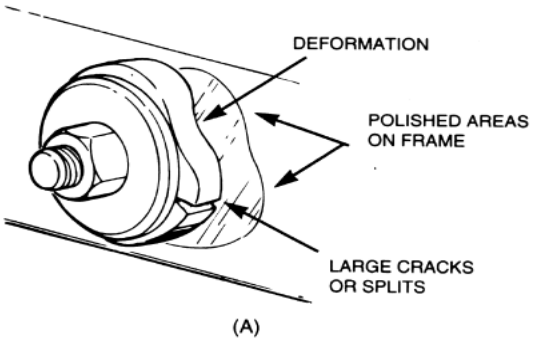
1. Bounce the suspension while listening for squeaks or other bushing related abnormal noises. If possible, place our finger lightly on the bushing while bouncing the front end; a noisy bushing will often have a rough, harsh feel. Noisy bushings can sometimes be cured by greasing them, but if they have squeaked for very long, they are probably worn and should be replaced.

2. Raise and support the car on a hoist or a jack stands.

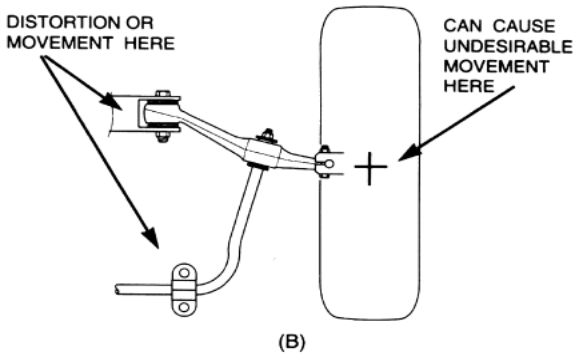
3. Swing the tire back and forth rapidly, so the turning stops strikes rather hard, and watch the control arm bushings. A very slight amount of side motion is acceptable, but a definite motion or jumping of the control arm on the shaft indicates a faulty bushing.

Strut rod bushings are rubber bushings that are compressed tightly against each side of an opening in the frame bracket. If they become weak, the outer end of the lower control arm will have an excessive amount of travel in a forward and backward direction.





(A)



(B)

Strut rod bushing failure is often indicated by a "thump" or "clunk" as the brakes are applied. These bushings are checked visually.

To check strut rod bushings, you should:

1. Raise and support the car on a hoist or jack stands.

2. Grip the bushing end of the strut rod and shake it up and down; any free play indicates a faulty bushing.

Inspect the bushing for hard cracks, rubber breaking, and severe distortion of the rubber; also check for signs of contact between the metal backup washer and the bushing bracket. Any of these indicate a faulty bushing.

3.1.5 Road Test for suspension system

A technician road tests the vehicle to confirm the nature of the problem and also to try to determine the cause. Most technicians have a preferred test route that provides various bumps and road surfaces and is away from heavy traffic. During a road test, the vehicle is driven in a manner to try to simulate the particular problem. In other words, if you are checking for a noisy shock, you want a rough road; if you are checking a pull condition or vibration problem, you want a smooth road. Finding a good test route that is close to the shop can be difficult in many metropolitan arrears.

While conducting a road test, you should observe the following guidelines:

- Make sure the vehicle is safe to operate by quickly checking the tires, brake pedal operation, and steering wheel feel.
- Observe all pertinent traffic laws.
- Use the vehicle's seat and shoulder belt.
- Drive the vehicle in a normal manner so you will not cause any additional wear or damage.
- Note the operation of the ABS and airbag warning lights if the vehicle is so equipped.

During the test, the technician will try to accomplish the following:

- Confirm the customer's complaint
- Pin down the problem area, front or back and right or left side.
- Determine the nature of the problem (i.e. noise, vibration, shake or pull)

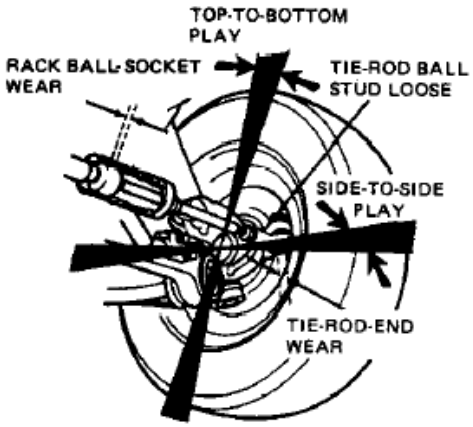
- Determine whether the problem is vehicle speed sensitive and what speed it is most noticeable, whether it is torque sensitive, and whether it is engine speed sensitive or gear ratio sensitive.
- Determine whether it is a tire, suspension, steering alignment, or brake problem.

3.2 Remove and adjust steering system components

Looseness in the steering linkage can cause wheel shimmy, uneven braking problems, and excessive tire wear. To check from loose steering linkage, turn off the air-suspension switch (trunk switch) on vehicle with air springs.

Raise the vehicle until the front tires clear the floor. Start the engine if the vehicle has power steering. Use a brake-pedal depressor or have an assistant apply the foot or service brakes. This eliminates any play caused by loose wheel bearings.

Grasp both tires at the front and push out and then pull in. On vehicles with 16-inch (406 mm) diameter or smaller wheels, the maximum movement at the front or rear of each tire should be ¼ inch (6.5 mm) or less. Excessive tire movement indicates worn linkage parts such as wear in the tie-rod ends or rack ball socket. Replace the defective parts and any tie-rod end that has torn boot. Then align the wheels. Another method of checking the steering linkage is the dry-park check. Park the vehicle on a dry surface with the weight on the wheels.



With the engine off and the steering wheel unlocked, watch the various connecting parts when the steering wheel is moved. Movement between the tie-rod end and the steering arm indicates a worn tapered-hole in the steering arm or loose ball-stud in the tie-rod end. Check each tie-rod end and other wear points for excessive looseness, binding and roughness.

3.2.1 Checking Steering Gears

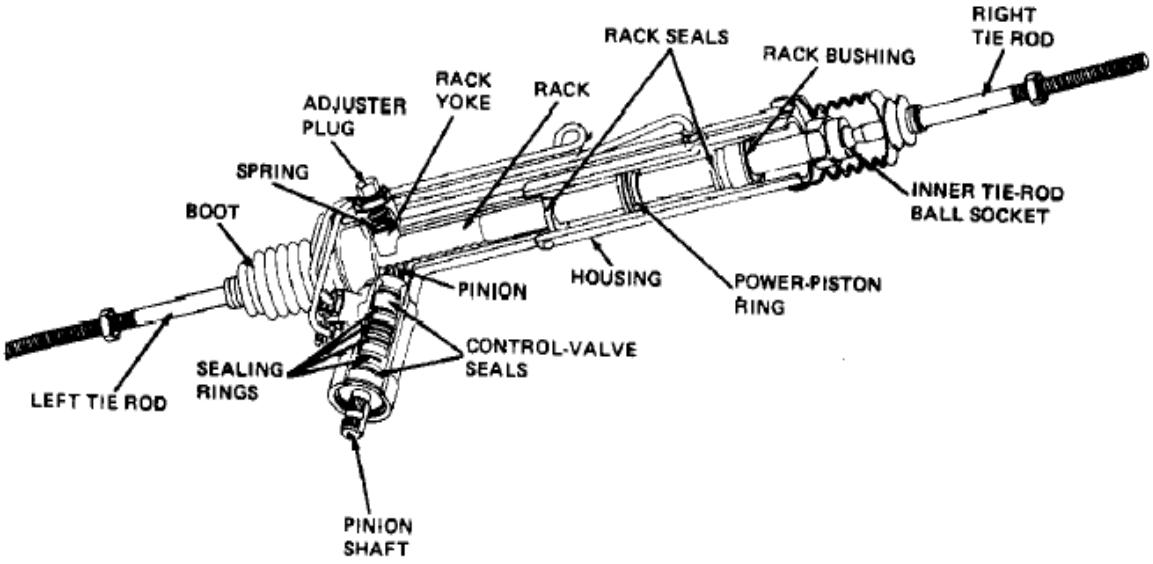
When there is excessive looseness in the steering, find out if the looseness is in the steering gear. Sometimes a steering-gear adjustment eliminates the looseness. However, an adjustment cannot correct for defective bearing or excessive wear.

1. **Recirculating-ball steering gear.**

With the wheels on the floor, turn the steering wheel one way and then the other. If excessive steering-wheel movement is required to move the Pittman arm, the steering gear is worn or needs adjusting. Two adjustments on the recirculating ball steering gear are the worm-bearing preload and the over center preload. The worm-bearing preload takes up the worm-shaft endplay. The over center preload removes backlash between the worm and the sector gear. These adjustments are usually made on the steering gear after removing it from the vehicle.

2. **Rack-and-pinion steering gear.**

The rack is supported at two points in the housing. The rack bushing supports the right end. The rack yoke supports the left or control-valve end. A spring behind the yoke pushes the rack into the pinion. This rack-to-pinion preload is the rack-yoke clearance. It maintains the proper mesh between the pinion and the rack. The rack housing includes an adjuster plug, screw, or shim pack for adjusting rack-yoke clearance.



3.2.2 Checking Wheel Bearing

Wheel bearings are usually either ball or tapered-roller bearings. These may be adjustable or non-adjustable. The front hubs of rear-drive vehicles and the rear hubs of front-drive vehicles are often supported by two adjustable roller bearings. The inner bearing and outer bearing mount on the stationary spindle and should have no preload. Front-drive vehicles have two ball or tapered-roller bearings in each steering knuckle. These bearings are permanently lubricated and not adjustable.

1. **Checking adjustable wheel bearings**

Turn off the air-suspension switch (trunk switch) on vehicles with air springs. Raise the vehicle until the tires clear the ground. Support the vehicle so the ball joints are loaded. This means they are carrying the weight of the vehicle. Grasp the tire at the top and bottom and rock it in and out. If the outer edge of the tire moves more than 1/8 inch (3 mm), have an assistant apply the brakes and rock the tire again. If this eliminates the movement, the wheel bearings are loose.

2. **Checking non-adjustable wheel bearings**

To check non-adjustable wheel bearings on General Motors and other vehicles, raise the tires off the ground. Remove the wheels and the disc-brake calipers or brake shoes. Install two wheel nuts to hold the drum or disc in place. Mount a dial indicator against the hub. Measure the endplay while pushing in and pulling out on the drum or disc. If the endplay exceeds 0.005 inch (0.13 mm), replace the hub-and-bearing assembly. The wheel bearings cannot be replaced separately.

3.2.3 Inspecting ball joints

Various methods are used to check ball joints. Some have built-in wear indicators. In others, the amount of wear is measured. Replace any ball joint that has a torn boot.

1. **Wear-indicating ball joints**

Many ball joints have a built-in wear indicator in the cover. This is slightly protruding boss into which a grease fitting may be threaded. On a new ball joint, the boss protrudes 0.050 inch (1.27 mm). It recedes into the cover as the ball joint wears. To check a wear –indicating ball joint, the weight of the vehicle should be on the wheels so the ball joints are loaded. Wipe the grease fitting and boss to remove all dirt and grease. Observe the cover, or scrape a fingernail, steel scale, or screwdriver across it. If the boss is flush with or inside the cover, the ball joint is worn and should be replaced.

Similar check of the lower ball joints is made on Chrysler front-wheel-drive vehicles. However, the wear indicator is that the grease fitting loosens as the ball joint wears. With the weight of the vehicle on the wheels, try to move the grease fitting with your fingers. Replace the ball joint if the grease fitting has any movement.

2. Ball joints without wear indicators

To check ball joints without wear indicators, raise the front end. Support the vehicle at the proper points to remove the load from the ball joints. Attach a dial indicator to the control arm. Place the dial indicator plunger against the steering knuckle or pinch-bolt around the ball-joint stud. The dial indicator will show any movement between the ball-joint stud and its socket.

Check vertical movement by lifting the tire and wheel with a pry bar while observing the dial indicator. Some ball joints are preloaded with rubber or springs under compression. They should have very little vertical movement. These ball joints are marked as preloaded in specification tables. Check horizontal movement by grasping the top and bottom of the tire, and moving it in and out. More horizontal movement as indicating ball-joint wear. Replace the ball joint if either vertical or horizontal movement exceeds the manufacturer's specifications. Then check the wheel alignment.

3.2.4 Checking Shock Absorbers And Strut Dampers

One test of shock absorbers and strut dampers is the bounce test. Bounce the vehicle at each corner by pushing down and releasing it. The vehicle should return to its original height and stay there. If it continues to bounce up and down, the shock absorber or strut damper is probably defective and should be replaced. Check the shock absorber or strut for wetness and leaking fluid. A shock absorber or strut damper that has lost fluid will not work properly and should be replaced. The units are sealed and fluid cannot be added.

3.3 Remove and adjust Brake system

A brake inspection is performed to determine the condition of the brake system. The inspection can determine the cause of complaint or service as preventive maintenance to determine when if service is necessary.

To perform a brake inspection you should:

1. Depress and release the brake pedal several times.
2. Depress the pedal heavily. There should be no sponginess and the pedal should stop with at least one-half of the available pedal travel left in reserve.
3. Depress the pedal moderately, about 25-35 lb. For about 15 seconds, making sure it does not sink to the floor.
4. Depress and release the pedal several times under varying amounts of pressure as you watch the warning light on he dash.

5. Check the brake warning light operation by cranking the engine. The light should come on as the engine is cranking. On cars equipped with ABS and/or airbags, this warning light should come on during cranking and remain on for a few seconds after the engine starts.
6. Apply the parking brake. The lever should not travel more than two-thirds of the available distance and should provide enough braking power to hold the car in place.
7. On cars equipped with power brakes, with the engine off, depress the pedal several times to exhaust the booster reserve. Hold the pedal down with a light pressure and start the engine, the pedal should drop slightly but noticeably. With hydraulic boosters, the pedal should drop and then rise back up. After running the engine several moments more, shut the engine off, wait 90 seconds and depress the pedal lightly. One or more assisted brake applications should occur.
8. Check the master cylinder for external leaks at the line fittings, mounting end. or reservoir cover.
9. Remove the reservoir cover, not the condition of the diaphragm, and make sure the vent hole on the cover is open.
10. Check the fluid level.
11. Run a clean finger around the bottom of the reservoir and checked for rust, dirt or other contamination.
12. Watch the fluid in the reservoirs as the pedal is depressed

    CAUTION: Do not lean directly over a master cylinder during brake application or release. Fluid can spurt or spray high enough get on your face or you eyes. It is a good practice to cover the reservoir wt clear plastic wrap to contain the fluid so you can observe the movement.
13. Inspect the vacuum hose and check valves, hydraulic lines, and electrical connections to make certain they are in good condition.
14. Raise and securely support the car.

    NOTE: The rear axles of some FWD cars will bend if lifted by the center of the axle. These axles should be lifted one at a time, with the place near the spring.
15. Rotate and shake or rock each of the wheels as you checks for excessive looseness and free rotation of the wheel or axle bearings.
16. Removed at least one front and one rear wheel using the following procedure.
17. Remove any wheel covers (often locked)
18. Put an indexing mark on the end of the lug bolts that is closes to the valve stem.

19. Remove the lug nut using a six-point lug nut socket or lug wrench.
20. Remove the tire and wheel assembly.
21. Mark the drum next to the previously marked studs and remove the drum.

    Safety tip: OSHA requirement state. “There should be no visible dust during brake inspection and repair.” Removal of a brake drum can release dust and asbestos fibers. The recommended method of preventing this is to flood the brake assembly using a brake washer; rotate the drum as you thoroughly wet the inner components. Aerosol sprays and vacuum enclosures can also be used.

NOTE: On brake drums that are mounted on the front of RWD cars or at the rear of the FWD cars, the drum can often be removed at the wheel bearing as a wheel, hub, and drum assembly. And follow the manufacturer recommendation on drum removal if you are not sure of how to do it.

22. Check the brake lining for the amount and pattern of wear.
23. Check the brake springs for distortion, stretched, collapsed coils twisted or nicked shanks or severe discoloration.
24. Checked the wheel cylinder for leakage.
25. Check the drum friction surface for cracks, unusual wear, worn or distorted surface.
26. Removed the caliper in the manner recommended y the manufacturer.
27. Inspect the lining for wear, noting the amount and pattern.
28. Check the caliper mounting hardware for wear or distortion.
29. Check the caliper piston booth for cracks or tears and leakage. No fluid seepage is considered and acceptable.
30. Check the friction surfaces of the rotor for unusual wear.
31. Replace the caliper using the manufacturers recommended procedure. Being sure to tighten the caliper mounting bolts or guide pins t the correct torque.

    NOTE: When brake drag abnormally fast pad wear is the complaint, it is a good practice to check for excessive brake drag.
32. If one or more problems were located, or there was a complaint of specific problem and the cause has not been found, one or both of the other wheels need to be removed and the brake assemblies inspected. If a preventative maintenance inspection is being made or the cause of problem has been determined, replace the wheels. The following procedures should be used:

33. Check the lug bolts and the wheel nut bosses for worn or elongated holes. Damaged wheels should be replaced.
34. Snug down the lug nuts, making sure the tapered portion of the lug nut enters the tapered opening of the wheel nut bosses.
35. Lower the car onto the ground and tighten the lug nuts to the correct torque using tightening pattern that moves back and forth across brake drum or rotor can distorted by over tightening the lug nuts or using the wrong order.
36. Replace the wheel cover or hub cap using a rubber hammer or the hammer portion of the hub cap tool. NOTE: Uneven or excessive lug nut torque can cause braking problems.
37. SAFETY TIPS: It is a good practice to retighten the lug nut after driving 10 to 20 miles and it is a good idea to check lug nut tightness again after 100miles or 161 KM.
38. Check all visible lines for kinks or collapse sections that might cause fluid restriction or leaks.
39. Check the parking brake cables equalizer and linkage.
40. Lower the car and operate the brake pedal through several slow, complete strokes until a firm pedal is obtained.
41. Road test the car on streets with little or no traffic and make several stops from speeds of 20 to 25 mph (30-40km) at different pedal pressures. While the stop is occurring, check for pull, grab, squeal or other unusual noises; excessive dive or pulsating pedal. Any faults indicate a need for inspection to determine their cause.
42. Evaluate the findings of your inspection and make your recommendations on the inspection report.

Lap Test 3:1

Instructions:

Given necessary templates, tools and materials you are required to perform the following Performing minor under chassis systems service.

Task 1. Removing and Assemble suspension system components

Task 2. Removing and Assemble steering system components

Task 3.Removing and Assemble Brake system components

Unit Four: Cleanup work area and maintain the equipment

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Work place equipment and tools properly
- Brake fluid and asbestos materials

This unit will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Keeping work place equipment and tools properly
- Handling brake fluid and asbestos materials

4.1 Keeping work place equipment and tools properly

Because the work takes place around potentially dangerous machinery, tools and chemicals, automotive repair poses certain dangers to mechanics. You might never make your service area completely free of danger, but you can significantly reduce the risk of injury by providing regular training and requiring that technicians follow basic safety procedures on the job.

4.1.1 Personal Protective Equipment and Dress

Employee attire should consist of long sleeve shirts and long pants that help protect arms and legs from cuts, scrapes and burns. Avoid loose clothing that could get caught in machines or equipment. Require that employees tie back any long hair and remove body jewelry before working with machinery. Make all appropriate protective equipment available to employees, including safety glasses, goggles, chemical-resistant gloves and kneepads. Ensure that employees use safety equipment when it is required.

4.1.2 Chemical, Electrical and Fire Safety

All chemicals used in the shop should be properly labeled with safety information. Keep safety data sheets for all chemicals present. The shop should have a functioning eye-wash station in case of emergency.

4.1.3 Precautions for Working on Vehicles

Require that all employees who operate motor vehicles are properly licensed, and that they use safety belts while operating motor vehicles. Engage the parking brake and block both sets of wheels before working on a vehicle. Remove the keys before performing mechanical work. Disconnect the battery before performing work to an automobile's electrical system.

4.1.4 Workplace Habits

Safe workplace habits can greatly reduce the potential for injury in the automotive repair industry. Provide regular safety training and equipment training. Only allow trained and certified technicians to repair vehicles. Keep the shop floor free of clutter to minimize the risk of tripping, and use "wet floor" signs after cleaning or spills. When a tool or piece of equipment is in need of repair, tag it with a sign or sticker so employees don't use it by accident. Do not allow workers to smoke on or near the shop floor.

4.2 Handling brake fluid and asbestos materials

4.2.1 Brake fluid handling

Stores, handles, and disposes of its brake fluid can either help it save or lose money. Here are some tips to keep the savings high.

- Always store brake fluid in its original container and make sure the cap is very tight. Store it in a clean, dry area away from dampness.
- Never reuse brake fluid that has been drained from the brake system or even fresh fluid that has been allowed to sit in an open container, because brake fluid is quickly contaminated by dust, air, and moisture.
- If your brake system uses DOT-5 brake fluid, do not add either DOT-3 or DOT-4 fluid. They can react badly with each other and corrode your brake system.
- Never use brake fluid with a DOT rating lower than recommended in the owner's manual. Brake fluid with a low DOT rating could boil and cause soft brake operation.
- Do not spill conventional glycol-based DOT-3, DOT-4, or DOT-5.1 brake fluid on your vehicle as it will ruin your truck's body paint. However, silicone-based DOT-5 fluid will not harm most paints.
- Do not overfill your master cylinder reservoir. Always leave room for hydraulic fluid to expand when it gets hot. Conversely, never permit the master cylinder reservoir to become empty or low.
- Never clean brake system components with mineral-based solvents such as kerosene, gasoline, acetone, or paint thinner. Such fluid will damage rubber cups and seals by causing them to soften, distort, or swell, causing the brake system to fail.
- Repair shops occasionally deal with small amounts of brake fluid. Depending on the additives used, brake fluid may or may not be hazardous. However, it can become hazardous when it is contaminated with brake cleaner from a spray can, which contains chlorinated solvents. Because brake fluid is not crude oil-based, it should not be added to used oil.
- Collect brake fluid in a separate, marked, closed container and identify a waste management company that will recycle it.
- Determine through testing if your brake fluid is hazardous, and manage it accordingly.
- If your brake fluid is determined to be non-hazardous, check whether the landfill will accept brake fluid absorbed with cat litter.

4.2.2 Handling of asbestos

Asbestos, a naturally occurring mineral fiber that is highly heat resistant, can cause serious health problems when inhaled into the lungs. If products containing asbestos are disturbed, thin, lightweight asbestos fibers can be released into the air. Persons breathing the air may then inhale asbestos fibers.

Continued exposure can increase the amount of fibers deposited in the lung. Fibers embedded in the lung tissue over time may result in lung diseases such as asbestosis, lung cancer, or mesothelioma. It can take from 10 to 40 years or more for symptoms of an asbestos-related condition to appear. Smoking increases the risk of developing illness from asbestos exposure.

A. Protection from asbestos exposure

If you are not able to determine whether your brakes or clutch contain asbestos, you may want to consider having your brakes or clutch serviced at a commercial automotive shop. OSHA requires special work practices for professional automotive technicians. If, however, this is not possible and you do not have access to the equipment professional automotive shops use to comply with the OSHA work practices, you may want to consider using the wet wipe method described in this brochure (www.osha.gov/SLTC/asbestos/standards.html).

This method has been deemed acceptable by OSHA for shops that service no more than five brake or clutch jobs per week.

Work Practice Don’ts for Mechanics:

It is recommended that you:

• Do not use compressed air for cleaning.

Compressed air blows dust into the air.

• Do not clean brakes or clutches with a dry rag, brush (wet or dry), or garden hose.

• Do not use an ordinary wet/dry vacuum without a high-efficiency particulate air

(HEPA) filter to vacuum dust. Invisible particles of brake or clutch dust can stay in the air and on your clothes long after a job is complete.

• Avoid taking work clothing inside the home or tracking dust through the house after performing brake and clutch work to prevent exposing your family to dust particles that may contain asbestos.

Work Practice Do's for Home Mechanics:

It is recommended that you:

• Use pre-ground, ready-to-install parts.

• If a brake or clutch lining must be drilled, grooved, cut, beveled, or lathe-turned, use low speeds to keep down the amount of dust created.

• Use machinery with a local exhaust dust collection system equipped with HEPA filtration to prevent dust exposures and work area contamination.

• Change into clean clothes before going inside the home and wash soiled clothes separately.

• Minimize exposure to others by keeping by standers, as well as food and drinks, away from the work area.

B. Dispose of waste that contains asbestos

Employers of professional automotive technicians must ensure that they or their waste haulers dispose of waste that contains brake or clutch dust, including wet rags used to wipe this dust, in accordance with Federal and local regulations, including the OSHA asbestos waste disposal regulations. OSHA require that, before waste containers with brake and clutch dust and other asbestos waste in them are collected, they must be sealed. The containers also must be impermeable and must be appropriately labeled. These regulations do not apply to home mechanics. For home mechanics, EPA recommends that asbestos waste be double-bagged and disposed of following appropriate local regulations to minimize exposure.

Self-Check 4:1

Directions:

Answer all the questions listed below.

1. How handle properly a Brake fluid?
2. What are Protection method from asbestos exposure?
3. Work Practice in exposed to asbestos what don’ts for Mechanics?
4. Work Practice in exposed to asbestos what do’s for Mechanics?
5. What are the method of dispose that contains asbestos?

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