MODULE CONTENT

| Unit of Competency | **DIAGNOSE AND REPAIR STEERING SYSTEM** |
| --- | --- |
| Module Title | **DIAGNOSING AND REPAIRING STEERING SYSTEM** |
| Module Descriptor | This unit identifies the competence required to diagnose and repair the steering systems. |
| Nominal Duration | **hours** |
| Summary of the Learning Outcomes: | |
| Upon completion of this module the student must be able to: | |
| LO1. Prepare to diagnose and repair steering system | |
| LO2. Diagnose steering system | |
| LO3. Repair steering system | |
| LO4. Complete work processes | |

**LEARNING EXPERIENCES**

**LEARNING OUTCOMES NO. 1**

**PREPARE TO DIAGNOSE AND REPAIR STEERING SYSTEM**

| **Learning Activities** | **Special Instructions** |
| --- | --- |
| Read Information Sheet 3.1-1 Prepare to diagnose and repair steering system | If you have some problem with the content of the information sheet don’t hesitate to approach your Trainer.  If you feel that you are now knowledgeable on the content of the information sheet, you can now answer the self-check provided in the module. |
| Answer Self-Check 3.1-1 on Prepare to diagnose and repair steering system | Try to answer the Self-check without looking at the Answer Key  Compare your answer to Answer Key 3.1-1 |
| Observe Trainer’s demonstration on Task Sheet 3.1-1 on Prepare to diagnose and repair steering system | Listen carefully and attentively so that you may be able to perform a task correctly  Ask questions if are in doubt for clarification |
| Perform the Task Sheet 3.1-1 on Prepare to diagnose and repair steering system | Remember the step-by-step procedure the Prepare to diagnose and repair steering system |
| Evaluate the performance using the Performance Criteria Checklist 3.1-1 | Repeat the task in case fail to meet the criteria |

**INFORMATION SHEET 1.1-1**

**PREPARE TO DIAGNOSE AND REPAIR STEERING SYSTEM**

**Learning Objectives:**

After reading this **Information Sheet**, you must be able to:

1. Made final inspection.
2. Turned-over vehicle.
3. Restored work area.
4. Managed wastes.
5. Checked and stored tools and equipment.
6. Accomplished workplace documents.

**STEERING SYSTEM**

The purpose of the steering system is to turn the front wheels. In some cases, it also turns the rear wheels. The wheels constantly change direction, while switching lanes, rounding sharp turns, and when avoiding roadway obstacles.

**MANUAL – STEERING SYSTEMS**

The steering system is composed of three major subsystems: the steering linkage, steering gear, and steering column and wheel. As the steering wheel is turned by the driver, the steering gear transfers this motion to the steering linkage. The steering linkage turns the wheel to control the vehicle’s direction (Figure 44 – 1). Although there are many variations to this system, these major assemblies are in all steering systems.

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**Figure 44-1 Allowing a vehicle to do something other than go straight is the job of the steering system.**

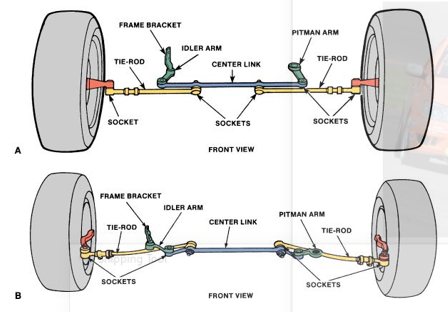
**Steering Linkage**

The term steering linkage is applied to the system of pivots and connecting parts placed between the steering gear and the steering arms that are attached to the front or rear wheels that control the direction of the vehicle travel. The steering linkage transfer the motion of the steering gear output shaft to the steering arms, turning the wheels to maneuver the vehicle.

The type of front-wheel suspension (independent wheel suspension are compared with a solid front axle) greatly influences steering geometry. Most passenger cars and many light trucks and recreational vehicles have independent front-wheel suspension systems. Therefore, a steering linkage arrangement that tolerates relatively large wheel movement must be used.

**Parallelogram Steering Linkage**

A parallelogram type of steering linkage arrangement was at one time the most common type used in passenger cars. Now it is found mostly on larger cars, pickups, and larger SUVs. It is used with the recirculating ball steering gear and can be classified into two distinct configurations: parallelogram steering linkage placed behind the front wheel suspension (Figure 44 – 2A) and parallelogram steering linkage placed ahead of the front-wheel suspension (Figure 44 – 2B). This type of steering linkage is most often used where motor and chassis component would interfere with normal operation of the steering linkage.

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**Figure 44-2 A parallelogram steering system mounts (A) behind front suspension and (B) ahead of front suspension.**

These designs are the basic steering systems used in conjunction with independent front-wheel suspension geometry. Road vibrations and impact forces are transmitted to the linkage from the tires, causing wear and looseness in the system, which permits intermittent changes in the toe setting of the front wheels, allowing the further tire wire.

In a parallelogram steering linkage, the tie rods have ball socket assemblies at each end. One end is attached to the wheel’s steering arm and the other end to the center link.

The components in a parallelogram steering linkage arrangement are the pitman arm, idler arm, links and tie rods.

Pitman Arm The pitman arm connects the linkage to the steering column through a steering gear located at the base of the column. It transmits the motion it receives from the gear to the linkage, causing the linkage to move left or right to turn the wheels in the appropriate direction. It also serves to maintain the height of the center link. This ensures that the tie rods are able to be parallel to the control arm movement and avoid unsteady toe setting of bump steer. Toe, a critical alignment factor, is a term that defines how well the tires point to the direction of the vehicle.

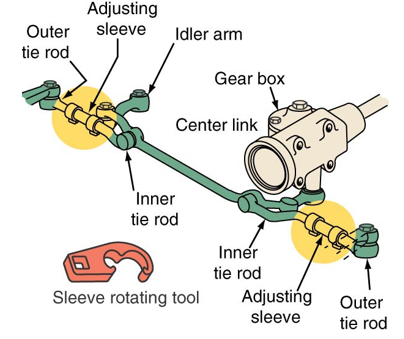
The are two basic types of pitman arms: wear and nonwear. Service needs differ, depending on which type of arm id used. Nonwear arms have tapered holes at their center link end s and normally need to be replaced only if mounted with excessive tolerance. Wear arm have studs at the center link end and are subject to deterioration from normal operation. These arms must be inspected periodically to determine whether they are still serviceable.

Idler Arm The idler arm or idler arm assembly is normally attached, on the opposite side of the center link, from the pitman arm and to the car frame, supporting the center link at the corner height. A pivot built into the arm or assembly permits sideways movement of the linkage. On some linkage, such as those on a few light-duty trucks, two idler arms are used.

Links Links, depending on the design application, can be referred to as center links, drag links, or steering links. Their purpose is to control sideways linkage movement, which changes the wheel’s direction. Because they are usually mounting location for the tie rods, they are very important in maintaining correct toe settings. If they are mounted at the correct height, toe is unstable and a condition known as the toe change or bump steer is produced. Center links and drag links can be used alone or in conjunction with each other; depending on the particular steering design.

There are several common designs of center links. Like pitman arms, they can be broadly characterized as either wear or nonwear. Center links with stud or bushing ends are likely to become unserviceable from the effect of the normal operation and should be inspected periodically. Links with open tapers are nonwear and usually need to be replaced only if they have been damaged in an accident of through excessive tolerance at the mounting position of the idler or pitman arms.

Tie Rods Tie rods are actually that make the final connections between the steering linkage and steering knuckles. They consist of inner tie-rod ends, which are connected to the opposite sides of the center link; outer tie-rod ends, which connect to the steering knuckles; adjusting sleeves or bolts, which join the inner and outer tie-rod ends, permitting the tie-rod length to be adjusted for correct toe settings **(Figure 44 – 3).**

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**Figure 44-3 A tie-rod assembly.**

The tie rods are subject to wear and damage, particularly if the rubber or plastic dust boots covering the ball stud have been damaged or are missing. Contaminants such as dirt and moisture can enter and cause rapid part failure. A special bonded ball stud, in which no boot is used, is a available for use on certain light-duty two-wheel-drive and four-wheel-drive trucks. An elastomer bushing bonded to the ball provides strong shook absorption and steering return in downsized vehicles.

**Rack and Pinion Steering Linkage**

Rack and pinion is lighter in weight and has components than parallelogram steering (Figure 44 – 4). Tie rods are used in the same fashion on both systems, but the resemblance stops there. Steering input is received from a pinion gear attached to the steering column. This gear moves a toothed rack that is attached to the tie rods.

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**Figure 44-4 A rack and pinion steering system.**

In the rack and pinion steering arrangement, there is no pitman arm, idler arm assembly, or center link. The rack performs the task of the center link. Its movement pushes and pulls the tie rods to change the wheel’s direction. The tie rods are the only steering linkage parts used in a rack and pinion system.

Most rack and pinion constructions are composed of a tube in which the steering rack can slide. The rack is a rod with gear teeth cut along one end- spur and helical. The other end is filter with two balls to which the ends of the divided track rods are attached. The rack meshes with the teeth of a small pinion at the end of the steering column. The two inner tie-rod ends, which are attached to the rack, are covered by rubber bellows boots that protect the rack from contamination. The inner tie rods connect to outer tie-rod ends, which connect to the steering arms. The rack and pinion housing is fastened to the vehicle at two or three points.

In some cases, the rack and pinion steering gear on unibody cars is bolted directly to a body panel, like a cowl. When this is done, the body panel must hold the steering gear in its correct location. The unibody structure must maintain the proper relationship of the steering and suspension parts to each other. Along with other advantages, the rack and pinion steering system combined with the MacPherson strut suspension system is found in most front-wheel-drive unibody vehicles because of their weight-and space-saving feature.

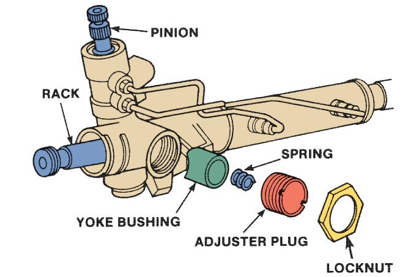
The driver gets a greater feeling of the road with the rack and pinion because there are fewer friction points. This means a higher probability of car owners with steering complaints. Fewer friction points can reduce the system’s total ability to isolate and dampen vibrations.

Rack the rack is a toothed bar contained in a metal housing. The rack maintains the height of the steering components so that the tie-rod movement is able to parallel control arm movement.

The rack is similar to the parallelogram center link in that its sideways movement in the housing is what pulls or pushes the tie rods to change wheel directions.

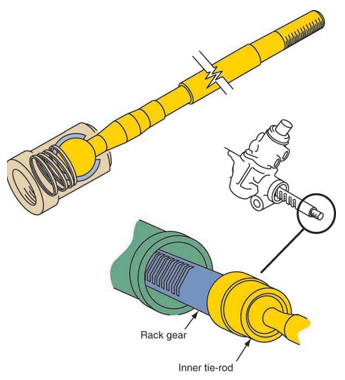
Pinion The pinion it is toothed or worm gear mounted at the base of the steering column assembly where it is moved by the steering wheel. The pinion gear meshes with the teeth in the rack so that the rack is propelled sideways in response to the pinion.

Yoke Adjustment The rack-to-pinion lash, or preload, affects steering harshness, feedback, and noise. It is set according to the manufacturer’s specifications. And adjustment screw, plug, or shim pack are located on the outside of the housing at the junction of the pinion and rack to correct or set the yoke lash (Figure 44 – 5).

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**Figure 44-5 the rack preload (yoke lash) is adjusted by a screw, plug, or shim pack.**

Tie Rods Tie rods in rack and pinion system are very similar to those used on parallelogram systems. They consist of inner and outer ends and adjusting sleeves or bolts. The inner tie-rod ends on rack and pinion units are usually spring-loaded ball sockets that screw onto the rack ends (Figure 44-6). They are preloaded and protected against contaminant entry by rubber bellows or boots.

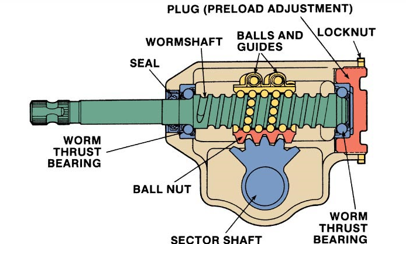
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**Figure 44-6 The inner tie rod is a spring-loaded ball socket in a rack and pinion steering box.**

**Manual Steering Gear**

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

The recirculating ball, as shown in Figure 44 – 7, is a generally found in larger cars. A sector shaft is supported by needle bearings in the housing and a bushing in the sector cover. A ball nut is used that has threads that mate to the threads of the wormshaft via continuous rows or ball bearings between the two. Ball bearings recirculate through two outside loops, referred to as ball return guide tubes. The ball nut has gear teeth cut on one face that mesh with gear teeth on the sector shaft. As the steering wheel is rotated, the wormshaft rotates, causing the ball nut to move up or down the wormshaft. Since the gear teeth on the ball nut are meshed with the gear teeth on the sector shaft, the movement of the nut causes the sector shaft to swing the pitman arm.

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**Figure 44-7 A top cutaway of a manual recirculating ball steering gear.**

The design of two separate circuits of balls results in an almost friction-free operation of the ball nut and the wormshaft. When the steering wheel is turned, the ball bearings roll in the ball thread grooves of the wormshaft and ball nut. When the ball bearings reach the end of their respective circuit, they enter the guide tubes and are returned to the other end of the circuits.

The teeth on the sector shaft and the ball nut are designed so that an interference fit exist between the two when the front wheels are straight ahead. This interference fit eliminates gear tooth lash for a positive feel when driving straight ahead. Proper mesh engagement between the sector and ball nut is obtained by an adjusting screw that moves the sector shaft axially.

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

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

The worm and roller gearbox is similar to the recirculating ball except a single roller replaces the balls and ball nut. This reduces internal friction, making it ideal for smaller cars. The steering linkage used with a worm and roller gearbox typically includes a pitman arm, center link, idler arm, and two-rod assemblies. The function of these components is the same as in the parallelogram steering linkage describe earlier in this chapter.

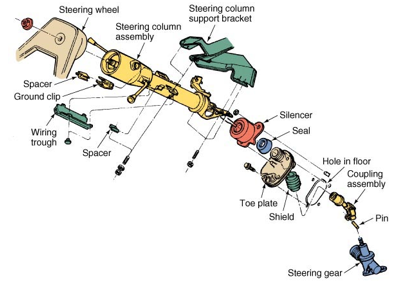
In operation, the steering shaft rotates the worm gear. It, in turn, engages the roller, causing the roller shaft to turn. The shaft moves the pitman arm left or right to steer the vehicle.

It must be noted that the steering gear does not cause the vehicle to pull to one does it cause road wheel shimmy.

Steering Wheel and Column

The purpose of the steering wheel and the column is to produce the necessary force to turn the steering gear. The exact type of steering wheel and column depends in the year and the car manufacturer. The steering column, also called a steering wheel to the steering gear.

Major parts of the steering wheel and column are shown in Figure 44 –8. The steering wheel is used to produce the turning effort. The lower and upper covers conceal parts. The universal joints rotate at angles. Support bracelets are used to hold the steering column in place. Assorted screws, nuts, bolt pins, and seals are used to make the steering wheel and column perform correctly. Since 1968, all steering column have collapsible feature that allows the column to fold to itself, on impact. This feature prevents injury to the driver.



**Figure 44-8 Typical steering column components. The steering wheel is splined to the shaft that extends through the column and down to the steering gearbox.**

In most vehicles equipped with a driver’s side air bag, the air bag assembly is contained in the center portion of the steering wheel. This assembly must be disarmed and removed before the steering wheel can be removed

Differences in steering wheel and column designs include fixed column, telescoping column, tilt column, manual transmission, floor shift, and automatic transmission column shift. The tilt column (Figure 44 –9) features at least five driving positions (two up, two down, and a center position). Both fixed and tilt column may house an emergency warning flasher control, a turn signal switch, ignition key, lights (high/low beams), horn, windshield wipers and washers, and a antitheft device that locks the steering system. On automatic-transmission-equipped vehicles, the transmission linkage locks also.

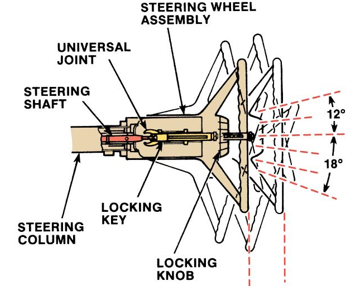
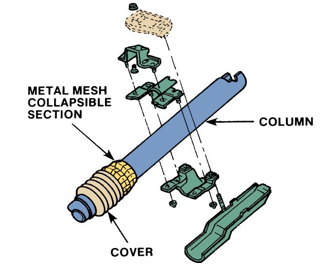


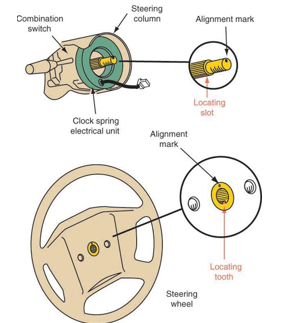
Figure 44-9 Tilt steering column operation.

Methods used to lock the shaft to the tube include a breakaway plastic capsule or a series of inserts or steel balls held in a plastic retainer that allow the shaft to roll forward inside the tube, there are also collapsible steel mesh (Figure 44 – 10) or accordion-pleated devices that give a way under pressure. After the vehicle has been in an accident, the steering column should be checked foe evidence of collapses column that has been pulled back, the collapsed portion must be replaced. All service manuals provide explicit instructions for doing this.

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**Figure 44-10 A collapsing mesh steering column.**

**The steering wheel is usually held in place on the steering column by either a bolt or nut (Figure 44 –11).**

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**Figure 44-11 The steering wheel is splined to the steering column and help in place by a nut.**

When the blocked tooth on the steering gear input shaft is in the 12 o’clock position, the front wheels should be in the straight-ahead position and the steering wheel spokes in their normal position. If the spokes are not in their normal position, they can be adjusted by changing the toe adjustment. This adjustment can be made only when the steering wheel indexing teeth or mating flats on the wheel hub and steering shaft prevent misindexing of these components. The alignment of the notches on the steering wheel hub and steering shaft confirm correct orientation.

**Steering Damper**

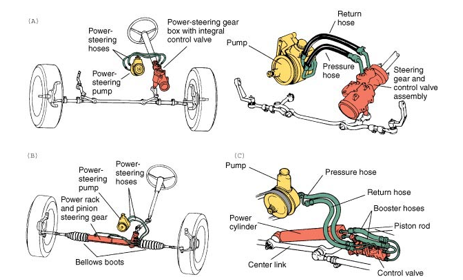
The purpose of a steering damper is simply to reduce the amount of road shock that is transmitted up through steering column. Steering dampers are found mostly on 4WD, especially those fitted with large tires. The dampers serves the same function as a shock absorber but is mounted horizontally to the steering linkage-one end to the center link and the other frame.

**POWER-STEERING SYSTEM**

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

Power steering can be broken down into two design arrangement: conventional and nonconventional arrangement, an electric motor and electronic controls provide power assistance in steering.

There are several power systems in use on passenger cars and light-duty trucks. The most ones are the integral-piston, and power-assisted rack and pinion system (Figure 44 –12).

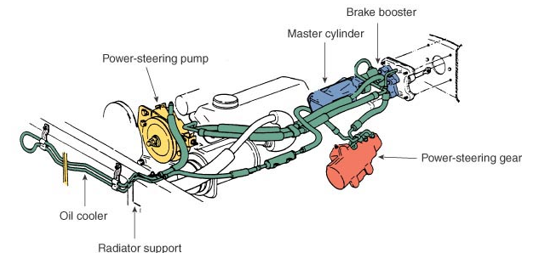
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**Figure 44-12 The three major power-steering system: (A) integral-piston leakage, (B) rack and pinion, and (C) external- piston linkage.**

**Integral Piston System**

The integral piston system is the most common conventional power-steering systems in used today. It consists of a power-steering pump and reservoir, power-steering pressure and return hose, and steering gear. The power cylinder and the control valve are in the same housing as the steering gear.

On the recent model cars and light trucks, instead of the conventional vacuum-assist brake, the hydraulic fluid form the power-steering pump is also used to actuate the brake booster. This brake system is called the hydro-boost system **(Figure 44 – 13).**

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**Figure 44-13 A typical hydro-boost system that uses the power-steering pump to power assist brake applications.**

**Power-Assisted Rack and Pinion System**

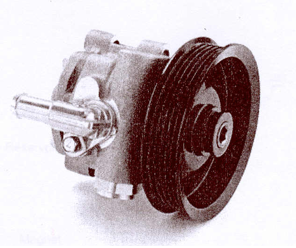
The power-assisted rack and pinion system is similar to the integral system because the power cylinder and the control valve are in the same housing. The rack housing act as the cylinder and the power piston is part of the rack. Control valve location is in the pinion housing. Turning the steering wheel moves the valve, directing pressure to either end of the back piston. The system utilizes a pressure hose from the pump to the control valve housing and a return line to the pump reservoir. This type of steering system is common in front-wheel-drive vehicle.

Components

Several of the manual-steering parts described earlier in this chapter, such as the steering linkage, are used in conventional power-steering system. The components that have been added for the power steering provide the hydraulic power that drives the system. They are the power-steering pump, flow control and pressure relief valves, reservoir, spool valves and power pistons, hydraulic hose lines, and gearbox or assist assembly on the linkage.

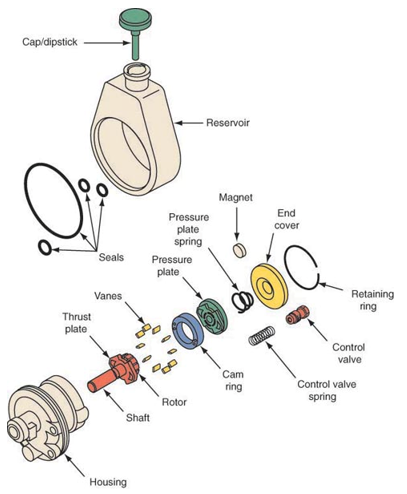
Power-steering Fluid the power-steering fluid can be checked hot or cold. Fluid level will vary with temperature, however and an accurate check is done when the engine is warm. The reservoir cap is usually marked for HOT and COLD fluid level on opposite sides of the dipsticks. Make sure to check the level on the right side of the dipstick. If necessary, add fluid to correct the level. Most manufacturers recommend a specific fluid for use in a power-steering system. Some, however, allow the use in a power-steering system. Some, however, allow the use of ATF as a substitute. Always check the service or owner’s manual for the proper fluid recommendation.

Power-Steering Pump the steering pump is used to develop hydraulic flow, which provides the force needed to operate the steering gear. The pump is belt craven from the engine crankshaft, providing flow any time the engine id running. It is usually mounted near the front of the engine (Figure 44 – 14). The pump assembly includes a reservoir and an internal flow control valve. The drive pulley is normally pressed onto the pump’s shaft.

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**Figure 44-14 A power-steering pump.**

There are four general types of power-steering pumps: roller, vane (Figure 14 – 15), slipper, and gear. Functionally, all pumps operate in the same basic manner. Hydraulic fluid for the power-steering pump is stored in a reservoir. Fluid is routed to and from the pump by hose and lines. Excessive pressure is controlled by a relief **valve.**

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**Figure 44-15 A vane-type power-steering pump.**

Power-Steering Pump Drive Belts Many power steering pumps are driven by a belt that connects the crankshaft pulley. The belt may also drive other components, such as the water pump. The sides of a V-belt are the friction surfaces that drive the power-steering pump. If the sides of the belt are worn and the lower edge of the belt is contracting the bottom of the pulleys driven by the V-belt must be properly aligned. If these pulleys are misaligned, excessive belt wear occurs.

A ribbed V-belt is used on many vehicles and this belt may be used to drive all the belt-driven components. Most ribbed V-belts have a spring-loaded automatic belt tensioner that eliminates periodic belt tension adjustments. Because the ribbed V-belt may used to drive all of the belt-driven components, these components are placed on the same vertical plane, which saves a considerable amount of underhood space. The smooth backside of the ribbed V-belt may used to drive one of the components. Regardless of the type of belt, the belt tension is critical. A power-steering pump will never develop full pressure if the belt is slipping.

Electronic Power-Steering Many new vehicles are using 12-volt mounted directly to the steering rack instead of pumps, hoses, and belts. These provide significant weight saving and the parasitic load on the battery is reduced.

Flow Control and Pressure Relief Valves A pressure relief valve controls the pressure output from the pump. This valve id necessary because of the variations in engine rpm and the end for consistent steering ability in all ranges from idle to highway speeds. It is positions in a chamber that is exposed to pump outlet pressure at one end and supply pressure at the other. A spring is used at the supply pressure end to help maintain a balance.

As the fluid leaves the pump rotor, it passes the end of the flow control valve and is forced through an orifice that causes a slight drop in pressure. This reduced pressure, aided by the spring, holds the flow control valve in the closed position. All pump flow is sent to the steering gear.

When engine speed increases, the pump can deliver more flow than is required to operate the system. Since the outlet orifice restricts the amount of fluid leaving the pump, the difference in pressure at the two ends of the valve becomes greater until pump outlet pressure overcomes the combined force of supply line pressure and spring, opening a passage that returns the excess flow back to the inlet side of the pump.

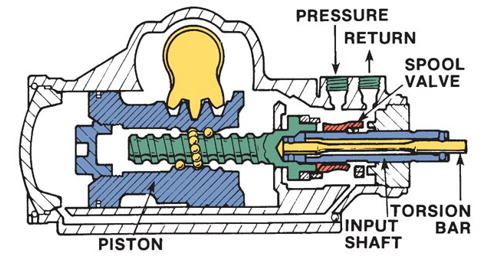
A spring and ball contained inside the flow control valve are used to relieve pump outlet pressure. This is done to protect the system from damage due to excessive pressure when the steering wheel is held against the stops. Since flow in the system is severely restricted, the pump would continue to build pressure until a hose rupture or the pump destroyed itself.

When the outlet pressure reaches a preset level, the pressure relief ball is force of its seat, creating a greater pressure differential at the two ends of the flow control valve. This allows the flow back to the pump inlet and pressure id held at a safe level.

Power-Steering Gearbox A power-steering gearbox is basically the same as a manual recirculating ball gearbox with the addition of a hydraulic assist. A power-steering gearbox is filled with hydraulic fluid and uses a control valve.

In a power rack pinion gear, movement of the rack is assisted by hydraulic pressure. When the wheel is turned, the rotary valve changes hydraulic flow to create a pressure differential on either side of the rack. The unequal pressure causes the rack to move toward the lower pressure, reducing the effort required to turn the wheels.

The integral power steering have valve and a power piston integrated with the gearbox. The spool valve directs the oil pressure to the left or right power chamber to steer the vehicle. The spool valve is actuated by the lever or a small torsion bar (Figure 44 – 16).

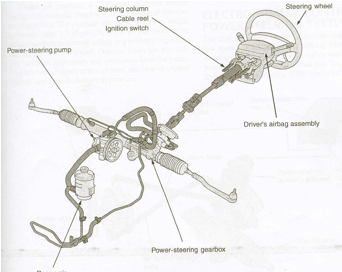
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**Figure 44-16 A torsion bar moves the spool valve to direct the oil flow to the piston.**

In linkage systems, the control valve is connected directly to the steering center link and the pitman arm on the steering gear. Any movement of the steering wheel and the pitman arm compresses the centering spring and moves the valve spool. This opens and closes a series of port directing fluid under pressure from the pump to one side or the other power cylinder piston.

The power cylinder in the linkage system is attached to the steering center link and the piston shaft is attached to the frame. As the fluid under pressure id directed to one side of the piston by the control valve, power assist is provided to aid the driver in moving the steering linkage and road wheels. Two lines connect the cylinder to the control valve. Each one functions as both the return line or the supply line, depending on the direction of the return.

Power-Assisted Rack and Pinion Steering Power-assisted rack and piston components are basically the same as for manual rack and pinion steering (Figure 44 – 17), except for the hydraulic control housing. As mentioned earlier, the power rack and pinion steering unit may be classified as integral. The rack functions as the power piston and the spool valve is connected the pinion gear.

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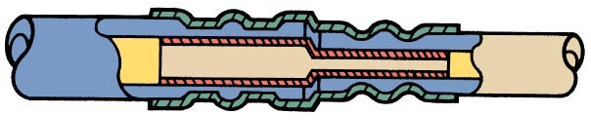
**Figure 44-17A complete power-assisted rack and pinion steering system.**

In a power rack and pinion gear, the piston is mounted on the rack, inside the rack housing. The rack housing is sealed on either side of the rack piston to form two separate hydraulic chambers for the left and right turn circuits. When the wheel is turned to the right, the rotary valves\ creates a pressure differential on either side of the rack piston. This causes the rack to move toward the lower pressure and reduces the total effort required to turn the wheels.

Power-Steering Hoses The primary purpose of power steering hoses is to transmit power (fluid under pressure) from the pump, to the steering gearbox, and to return the fluid ultimately tot the pump, to the steering gearbox, and to return the fluid ultimately to the pump reservoir. Hoses also, through material and construction, function as additional reservoirs and act as sound and vibration dampers.

Hoses are generally a reinforced synthetic rubber (neoprene) material coupled to metal tuning at the connecting points. The pressure side must be able to handle pressures up to 1,500 psi (10,342 kPa). For that reason, wherever there is metal tubing to a rubber connection, the connection is crimped. Pressure hoses are also subject to surges in pressure and pulsations from the pump. The reinforced construction permits the hose to expand slightly and absorb changes in pressure.

Two internal diameters of hose (Figure 44 – 18) may be used on the pressure side; the larger diameter or pressure hose is at the pump end. It acts as a reservoir as an accumulator absorbing pulsation. The smaller diameter or return hose reduces the effects of kickback from the gear itself. By restricting fluid flow, it also maintains constant backpressure on the pump, which reduces pump noise. If the hose is of one diameter, the gearbox is performing the damping function internally.

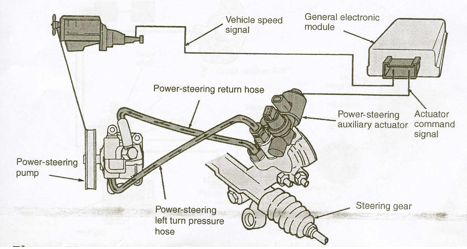
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**Figure 44-18 Power-steering hoses may have two internal diameters.**

Because of working fluid temperature and adjacent engine temperatures, these hoses must be able to withstand temperature up to 300o F (150 oC). Due to various weather conditions, they must also tolerate subzero temperature as well. Hose material is specially formulated to resist breakdown or deterioration due to oil to temperature conditions.

**ELECTRONICALLY CONTROLLED POWER-STEERING SYSTEM**

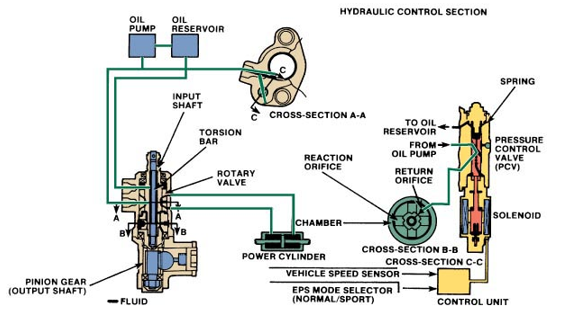
The object of the power steering is to make steering easier at low speeds, especially while parking. However, higher steering efforts are desirable at higher speeds in order to provide improved down-the-road feel. The electronically controlled power-steering system (EPS) systems (Figure 44-19) provide both of these benefits. The hydraulic boost of these systems is tapered off by electronic control as road speed increases. Thus, these systems require well under 1 pound (4.4 N) of steering effort at low road speeds and 3 pound plus (13.2 N) of steering effort at higher road speeds to enable the driver to maintain control of the steering wheel for improved high-speed handling.

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**Figure 44-19 A variable-assist power-steering system.**

A rotary valve electronic power steering system consists of the power-steering gearbox, power-steering oil pump, pressure hose, and the return hose. The amount of hydraulic fluid flow (pressure) used to boost steering is controlled by a solenoid valve that is identified as its PCV (pressure control valve).

The electronic power-steering system’s PCV (Figure 44 – 20) is exposed to spring tension on the top and plunger force on the bottom. The plunger slips inside an electromagnet. By varying the electrical current to the electromagnet, the upward force exerted by the plunger can be varied as it works against the opposing spring. The current flow to the electromagnet is variable with the vehicle road speed and, therefore, provides steering to match the vehicle’s road speed.



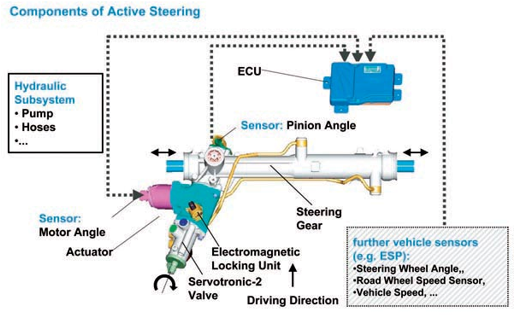
**Figure 44-20 An outline of electronic power-steering components. The EPS PCV is exposed to spring tension and plunge force.**

General Motors’ variable effort steering (VES) system relies on an input signal from the vehicle speed sensor to the VES controller to control the amount of power assist. The controller, in turn, supplies a pulse width modulated voltage to the actuator solenoid in the power-steering pump. The controller also provides a ground connection for the solenoid.

When the vehicle is operating at low speeds, the controller supplies a signal to cycle the solenoid faster so it allows high pump pressure. This provides for maximum power assist during cornering and parking. As the vehicle’s speed increases, the solenoid cycles less and the pump provides a lower amount of assist. This gives the driver better road feel during high speeds.

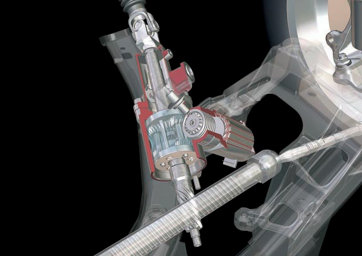
**Active Steering**

Active steering improves vehicle stability turning the wheel more or less sharply than turning the wheels more or less sharply than commanded by the turn of the steering wheel during some situations. Through inputs and computer programming, this system can adjust the steering to respond quickly to the threat of skidding (Figure 44 – 21).

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**Figure 44-21 The main components and circuits of an active steering system**

Current active steering systems are not true steer-by-wire systems. There is still a mechanical connection between the steering wheel and vehicle’s wheel (Figure 44 – 22). The systems have an over ridding drive built into the steering column. This drive is controlled by an electric motor, which is controlled by the system’s computer. The computer determines whether the steering angle needs to be changes and by how much. If the system fails, the planetary gear unit will rotate directly with the steering wheel.

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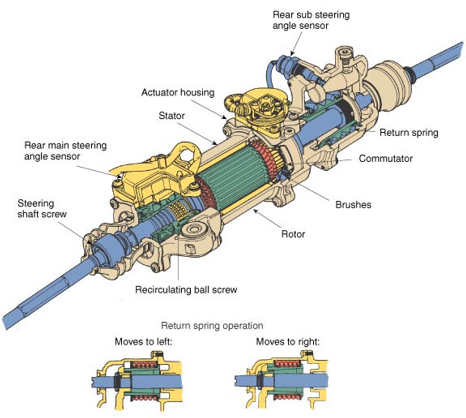
**Figure 44-22 The planetary gearset and electric motor that turn the road wheels when the steering wheel is turned.**

**General Service**

When servicing, as with any power-steering system, the first step **is to look fluid** leaks, damaged components a slipping drive belt, and so on. Only after these things have been checked and no problems have been found should be the electronics be suspected as the problem. Check the appropriate service manual for the correct troubleshooting procedures of the electronics.

**Electronic / Electronic Rack and Pinion System**

The electric/electronic rank and pinion unit replaces the hydraulic pump, hoses, and fluid associated with electronic controls and an electric motor located concentric to the rack itself (Figure 44 – 23). The design features a DC motor armature with a follow shaft to allow passage of the rack through it. The outboard housing and rack are designed so that the rotary motion of the armature can be transferred to linear movement of the rack through a ball nut with thrust bearings. The armature is mechanically connected to the ball nut through an internal/external spline arrangement.

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**Figure 44-23 An electric/electronic rack and pinion system**

The basis of system operation is its ability to change the rotation direction of the electric motor while being able to deliver the necessary amount of current to meet torque requirements at the same time. The system can deliver up to 75 amperes to the motor. The higher the current, the greater the force exerted on the rack. The direction of the turn is controlled by changing the polarity of the signal to the motor.

The field assembly houses permanent ceramic magnets while providing structural integrity for the gear system. In essence, the electronic/electric rack design allows for a direct power source to the rack and steering wheel movement through a sensor mounted on the in input shaft of the rack and pinion steering gear. After receiving directional and load information from the sensor, an electronic controller activates the motor to provide power assistance.

These units are readily retrofitted to conventionally equipped vehicles. As for servicing, there are currently no replacement parts available; therefore if the rack should become faulty should be replaced. Rebuilt kits, with complete installation instructions, are available.

Unlike conventional power steering, electric/electronic units provide assistance even when the engine stalls, since the power source is the battery rather than the engine-driven pump. The feel of the steering can also be adjusted to match the particular driving characteristics of cars and rivers, from high performance to luxury touring cars. It also eliminates hydraulic oil, which means no leaks.