CHAPTER 13
Hydraulic Power Steering Systems

FIGURE 13.1 Hydraulic fluid transmits the same force whether it passes through a single chamber or two chambers connected by a narrow passage.

FIGURE 13.2 A fluid applies a force equal to the applied force on a surface that is equal in size to the applying surface.
FIGURE 13.3 A typical integral power steering pump when the pump is mounted inside the reservoir.

FIGURE 13.4 Typical remote reservoir.

FIGURE 13.5 Typical power steering pump assemblies.
FIGURE 13.6 General Motors vane-type pump.

FIGURE 13.7 Vane pump operation. In phase 1, the rotor moves past the opposed suction ports, and the vanes move out to maintain contact with the ring.

FIGURE 13.8 Vane pump operation—continued. At phase 3, the vanes are at the end of the intake port of the pump and the cavity has reached its maximum volume.
FIGURE 13.9 Vane pump operation—continued. As the rotor continues to move during phase 5, the volume of the cavity decreases, which increases the discharge pressure.

FIGURE 13.10 Flow control valve.

FIGURE 13.11 The pressure-relief check ball unseats, allowing fluid to flow back into the pump inlet if the pressure rises above a certain limit.
FIGURE 13.12  The power steering fluid cooler, if used, is located in the return hose. Often the “cooler” is simply a length of return metal line that is arranged in a loop and routed near the front of the vehicle.

FIGURE 13.13  Forces acting on the rack piston of an integral power steering gear.

FIGURE 13.14  The rotary valve consists of inner and outer elements. The worm gear is part of the outer element and the torsion bar is part of the inner element.
FIGURE 13.15 When the steering wheel is in the straight-ahead position, all of the ports in a rotary valve are open equally to the pressure and return circuits.

FIGURE 13.16 During a left turn, the inner element turns so that the left-turn circuits are open to pressure and the right-turn circuits are open to the return circuit.

FIGURE 13.17 During a left turn, the high-pressure fluid helps push the piston along the worm gear, thereby reducing the steering effort from the driver.
FIGURE 13.18 During a right turn, the inner element turns so that the right-turn outlets are open to pressure and the left-turn outlets are open to the return circuit.

FIGURE 13.19 During a right turn, high-pressure fluid pushes the piston up the worm gear, moving the sector shaft and pitman arm to provide assist during a right turn.

FIGURE 13.20 During a left turn, the control valve directs pressure into the left-turn fluid line and the rack moves left (see inset).
FIGURE 13.21 The control valve routes high-pressure fluid to the left-hand side of the power piston, which pushes the piston and assists in moving the rack toward the right when the steering wheel is turned right.

FIGURE 13.22 Low-speed flow control.

FIGURE 13.23 High-speed flow control operation.
FIGURE 13.24 Pressure-relief mode. In this mode, the steering gear has blocked the flow of fluid from the pump and the pressure rises, which unseats the pressure-relief valve.

FIGURE 13.25 EVO actuator assembly.

FIGURE 13.26 Integrated with the pinion shaft is a spool valve that senses the level of torque in the shaft and applies hydraulic pressure to the steering rack whenever assistance is needed.
FIGURE 13.27 Magnasteer® system.

FIGURE 13.28 A typical service manual illustration showing the method to use to properly tension the accessory drive belt.

FIGURE 13.29 A check of the power steering fluid should include inspecting not only the level but the condition and color of the fluid, which could indicate a possible problem with other components in the steering system.
FIGURE 13.30 Some power steering fluid is unique to the climate, such as this cold climate fluid recommended for use in General Motors vehicles when temperatures are low.

FIGURE 13.31 Inspect both high-pressure and return power steering hoses. Make sure the hoses are routed correctly and not touching sections of the body to prevent power steering noise from being transferred to the passenger compartment.

FIGURE 13.32 A drawing showing how to connect a power steering analyzer to the system.
FIGURE 13.33 A power steering analyzer that measures both pressure and volume. The shut-off valve is used to test the maximum pressure of the pump.

FIGURE 13.34 Typical power steering pump showing the order of assembly. The high-pressure (outlet) hose attaches to the fitting (#16). The flow control valve can be removed from the pump by removing the fitting.

FIGURE 13.35 Typical tools required to remove and install a drive pulley on a power steering pump. Often these tools can be purchased at a relatively low cost from automotive parts stores and will work on many different makes of vehicles.
FIGURE 13.36 A typical submerged-type power steering pump. The pump is housed inside the fluid reservoir.

FIGURE 13.37 A punch is used to dislodge the retaining ring.

FIGURE 13.38 The driveshaft attaches to the drive pulley at one end and is splined to the pump rotor at the other end. The vanes are placed in the slots of the rotor.
FIGURE 13.39 The pump ring must be installed correctly. If it is installed upside down, the internal passages will not line up and the pump will have no output.

FIGURE 13.40 The shaft seal must be chiseled out. A thin metal shim stock should be used to protect the shaft from damage.

The tools required include a tie rod end puller and basic hand tools.
To help keep the steering wheel from rotating when the steering rack assembly is removed, a steering wheel lock is being used.

After safely hoisting the vehicle and removing the front wheels, the outer tie rod end retaining nuts are removed.

Use a tie rod taper breaker to separate the outer tie rods from the steering knuckle without harming the rubber grease boots.
After moving the protective cover aside, the bolt used to retain the intermediate shaft to the steering gear stub shaft is removed.

The hydraulic lines attached to the steering rack to the power steering rack assembly are removed using a line wrench.

After supporting the engine cradle using a tall safety stand, an air impact wrench with a long extension is used to remove the engine cradle bolts.
Removing the lower engine cradle bolts. This will allow the cradle to be lowered to gain access to the steering rack assembly.

The screw jack on the tall safety stands is rotated allowing the engine cradle to be lowered.

Removing the steering rack attachment bolts.
The steering rack assembly can be lifted out of the support brackets.

On this General Motors vehicle, the steering rack assembly is removed from the driver's side.

Before reinstalling the steering gear assembly, note the notch on the stub shaft.
Installation is the reverse of removal. Be sure that the rack is centered and check that the throughbolt is properly aligned with the notch in the steering rack stub shaft.

While using a tall safety stand to support the engine cradle, the retaining bolts are installed.

A socket is being used to keep the tapered tie rod end from rotating while the retaining nut is tightened with a wrench.
After the hydraulic lines and retaining bolts have been installed, the power steering pump reservoir is filled using the specified fluid.

To bleed the trapped air out of the system, the steering wheel is rotated lock to lock with engine off and the wheels off the ground.