CHAPTER 28
Servicing the Steering System

Introduction
• Many components make wheels steer.
• Well-functioning steering system is critical for safety of all on the road.

Steering System Overview (1 of 15)
• Steering system provides control.
  – Direction of travel
  – Maneuverability
  – Recovery from turns
  – Minimal transmission of road shocks
Steering System Overview (2 of 15)

• Four main parts
  – Steering column
  – Steering box
  – Steering linkage
  – Steering knuckles

Steering System Overview (3 of 15)

• Two main types of steering systems
  – Rack-and-pinion
  – Parallelogram

Steering System Overview (4 of 15)

• Parallelogram steering
• Rack-and-pinion steering
Steering System Overview (5 of 15)
• Steering geometry relationship between steering system, wheel positions, and suspension system
  – Ackerman principle

Steering System Overview (6 of 15)
• Rack-and-pinion steering system is used on majority of front-wheel drive vehicles.
  – Pinion
  – Rack
  – Inner tie-rod or socket
  – Outer tie-rod

Steering System Overview (7 of 15)
• The rack-and-pinion steering system.
  A. Pinion and rack.
B. Inner ball joint or socket.

C. Tie-rod.

Steering System Overview (9 of 15)

- Parallelogram steering system is more complicated than rack-and-pinion.
  - Pitman arm
  - Idler arm
  - Center link
  - Tie-rod
  - Tie-rod end
  - Adjustment sleeve

Steering System Overview (10 of 15)

- Tie-rod connects wheel assembly to center link via ball-and-socket pivoting joint.
• Four-wheel drive vehicles with beam axles have a single tie-rod connecting steering arms on each wheel assembly.

• All steering columns are fitted with collapsible sections.

• Intermediate shaft allows it to fold under.
• Malfunction switch
• Entertainment controls
A. Multifunction switch.  

B. Steering wheel entertainment controls.

Steering System Overview  (14 of 15)

Steering System Overview  (15 of 15)

- Tilting/telescoping mechanisms allow drivers to control steering wheel position.
- Driver’s side airbag provides collapsing cushion.

Steering Boxes  (1 of 6)

- Two main types of steering boxes
  - Rack-and-pinion
  - Worm
Steering Boxes (2 of 6)

- Rack is supported at both ends of rack housing by bushings.

Steering Boxes (3 of 6)

- Knuckle
  - Steering arm
  - Stub axle knuckle
  - Stub-axle carrier

Steering Boxes (4 of 6)

- Worm gearing uses worm and worm gear.
  - Turning front wheel was easier for drivers of early automobiles.
Steering Boxes (5 of 6)

• Worm-and-roller gearbox has an hourglass worm shaft that meshes with double-track roller.

Steering Boxes (6 of 6)

• Recirculating ball helps reduce lateral movements.
  – End play

Four-Wheel Steering Systems

• Rear wheels can be steered independently of or in conjunction with front wheels.
  – Active
  – Passive
Power Steering (1 of 13)

- Three types
  - Hydraulically assisted
  - EPHS
  - Fully electric power steering

Power Steering (2 of 13)

- Pressure seals isolate power section from the rest of power-assisted rack-and-pinion.

Power Steering (3 of 13)

- Power piston and seals slide in cylinder in housing of recirculating ball steering box.
• Rotary displacement is allowed by torsion bar connected to pinion gear.

• Fluid flow is directed into rotary valve through drilled holes in outer sleeve.

• All power steering pumps have flow-control valve.
  - Controls position of needle
Power Steering (7 of 13)

- Valve moves and uncovers return port to pump inlet.

Power Steering (8 of 13)

- EPHS replaces customary drive belts and pulleys in a conventional rack-and-pinion system.
  - Brushless motor
- EAS eliminates all hydraulic components and fluid.
  - EPS system

Power Steering (9 of 13)

- Four types of EPS systems
  - Column-assist
  - Pinion-assist
  - Rack-assist
  - Direct-drive
Power Steering (10 of 13)

- Rack-assist is power assist unit attached to steering gear rack.

Power Steering (11 of 13)

- Steering sensor performs two functions.
  - Converts steering torque input and direction into voltage signals for engine control unit (ECU)
  - Converts rotation speed and direction into voltage signals for ECU to monitor

Power Steering (12 of 13)

- Microprocessor control unit analyzes inputs to determine how much power assistance is required.
- ECU sends command to power unit.
Power Steering (1 of 13)

- Electronic steering control unit turns system off by actuating a fail-safe relay.
- Higher voltage electrically assisted power-steering systems were developed for modern hybrid vehicles.

Diagnosis (1 of 8)

- Many problems associated with steering systems are mechanical.

Diagnosis (2 of 8)

- Tools used in diagnosis and repair:
  - Dial indicator
  - Belt tension gauge
  - Tie-rod puller
  - Pickle forks
  - Pitman arm puller
• Tools used in diagnosis and repair (cont’ d):
  – Tie-rod sleeve adjusting tools
  – Inner tie-rod socket tools
  – Inch-pound and foot-pound wrenches
  – Hammers
  – Air hammers
  – Pry bars

• Steering system specialty tools.
  A. Pitman arm puller.
  B. Tie-rod end puller.
  C. Tie-rod sleeve tool.
  D. Pickle fork.
  E. Power steering system analyzer.
  F. Inner tie-rod tool.
Diagnosis (6 of 8)

- Main problems in steering system are play and hard steering.
- Any power steering fluid leak is cause for repair.

Diagnosis (7 of 8)

- Steering gear issues in non–rack-and-pinion system:
  - Uneven effort needed for turning
  - Hard steering
  - Unusual noises when steering
  - Leaks

Diagnosis (8 of 8)

- Issues in rack-and-pinion system include same complaints as non–rack-and-pinion systems.
- Steering column issues:
  - Unusual noises
  - Looseness
  - Binding
Maintenance and Repair (1 of 10)

- Steering system does not normally require a lot of maintenance.
- Flush power steering system if:
  - Manufacturer specifies fluid change
  - Fluid appears to be contaminated or dirty
  - Major part of hydraulic system is replaced
  - Another serious mechanical problem occurs

Maintenance and Repair (2 of 10)

- Pressure test power steering system when:
  - Driver complains of hard steering
  - Repeated hose failures
- Fully diagnose the power steering pump before condemning the pump.

Maintenance and Repair (3 of 10)

- When power steering pump is removed or replaced, press-fit pump pulley must also be removed.
- Inspect power steering hoses regularly and replace at any sign of wear.
Maintenance and Repair (4 of 10)

- Inspect mounting bushings and brackets if:
  - Oil or power steering fluid leak
  - Loose steering
  - Noises when driving or turning
- Remove or replace rack-and-pinion steering gear only after examining all parts of system and full diagnosis.

Maintenance and Repair (5 of 10)

- Significant steering problems and tire wear result from problems in:
  - Pitman arm
  - Relay rod
  - Idler arm and mountings
  - Steering linkage damper
- Regular inspection of tie-rods can help identify steering problems.

Maintenance and Repair (6 of 10)

- Check gearbox in non-rack-and-pinion steering systems for worm bearing preload and sector lash if driver complains of loose steering.
- Vehicles with EPS should be tested when driver complains of either loose or hard steering.
Maintenance and Repair (7 of 10)

- After problem in electronically controlled steering system confirmed and codes pulled, research:
  - Codes
  - TSBs
  - Diagnostic procedure

Maintenance and Repair (8 of 10)

- Only course of action for electronically controlled steering system is complete replacement with new unit or wiring repair on system’s harness.

Maintenance and Repair (9 of 10)

- In hybrid vehicle, best course of action is refer to manufacturer’s service information.
- When working on or near steering column, airbags, pyrotechnic devices, or sensors, the SRS system should be disabled and enabled.
Maintenance and Repair (10 of 10)

- Clock spring must be replaced if damaged in any way.
- Regular inspection of steering column and its components can identify problems before they become dangerous.

Summary (1 of 12)

- The power steering system can be either a hydraulic or electric type.
- A basic steering system has four main parts: a steering column, a steering box, a steering linkage, and a steering knuckle.

Summary (2 of 12)

- Steering geometry is a geometric arrangement of linkages in the steering of a vehicle, designed to keep the wheels properly oriented through various positions of the steering and suspension systems.
- The rack-and-pinion steering system is used on the majority of front-wheel drive vehicles because of the space restriction under the hood.
Summary (2 of 12)

• The parallelogram steering system is used on larger vehicles where ride comfort is more important than sporty handling.

• When servicing the steering column, it is good practice to disarm the triggering system for the driver’s side airbag. If not properly disarmed, it could trigger accidentally.

Summary (4 of 12)

• Because of the critical nature of the airbag, it is imperative that it is always connected electrically to its control module, so it can be deployed when needed.

• The function of all steering boxes, whether manual or power, is the same: to transfer the rotary motion of the steering wheel into the side-to-side motion needed to make the wheels pivot left and right.

Summary (5 of 12)

• There are two basic types of steering boxes: those with rack-and-pinion gearing and those with worm gearing and sector shaft. In both types, the gearing in the steering box makes it easier for the driver to turn the steering wheel and, hence, the wheels.

• Four-wheel steering means the rear wheels can be steered independently of or in conjunction with the front wheels. There are two types: active and passive.
### Summary (6 of 12)

- There are three types of power steering: hydraulically assisted power steering, electrically powered hydraulic steering, and fully electric power steering.
- Electrically powered hydraulic steering replaces the customary drive belts and pulleys that drive a power steering pump in a conventional rack-and-pinion steering system with a brushless motor.

### Summary (7 of 12)

- The steering sensor performs two functions: First, as a torque sensor, it converts steering torque input and direction into voltage signals for the ECU to monitor. Second, as a rotation sensor, it converts the rotation speed and direction into voltage signals for the ECU to monitor.

### Summary (8 of 12)

- Higher voltage electrically assisted power-steering systems were developed for modern hybrid vehicles. The higher voltage battery system of the hybrid vehicle provides all the power, with no reliance on engine or hydraulic power.
Summary (9 of 12)

• Many of the problems associated with steering systems are mechanical, but as more EPS systems are produced, electrical faults are becoming more common. The main problems that arise in the steering system are play and hard steering; common causes are wear and poor lubrication.

Summary (10 of 12)

• Power steering fluid is critical to the proper functioning of the entire steering system. Any leak, no matter how small, is cause for repair.
• To maintain a safe-operating vehicle, regular inspection of the steering components is essential.

Summary (11 of 12)

• Pressure testing the power steering system is performed when the driver complains of hard steering or when there are repeated hose failures.
• Removing and replacing the rack-and-pinion steering gear should be considered only after examining all parts of the steering system and performing a full diagnosis to ensure the problem is not the result of some other fault.
Summary (12 of 12)

• Checking tie-rod ends is important in identifying steering problems because the ends are frequently damaged or worn.
• On vehicles equipped with EPS, the electric power assist system should be tested any time the driver complains of steering difficulties, either hard or loose.

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