

# Automotive Technology 6<sup>th</sup> Edition

## Chapter 120 STEERING COLUMNS & GEARS

### Opening Your Class

KEY ELEMENT	EXAMPLES
<b>Introduce Content</b>	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
<b>Motivate Learners</b>	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
<b>State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.</b>	<p>Explain learning objectives to students as listed below:</p> <ol style="list-style-type: none"> <li>1. Describe the purpose and function of a steering wheel.</li> <li>2. Explain how to remove a steering wheel.</li> <li>3. Discuss steering columns and intermediate shafts.</li> <li>4. Explain the purpose and function of conventional Steering gears</li> <li>5. Explain how a recirculating ball steering gear works.</li> <li>6. Describe how a rack-and-pinion steering gear works.</li> <li>7. This chapter will help prepare for Suspension and Steering (A4) ASE certification test content area "A" (Steering System Diagnosis and Repair).</li> </ol>
<b>Establish the Mood or Climate</b>	Provide a <b>WELCOME</b> , Avoid put downs and bad jokes.
<b>Complete Essentials</b>	Restrooms, breaks, registration, tests, etc.
<b>Clarify and Establish Knowledge Base</b>	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

**NOTE: Lesson plan is based on 6<sup>th</sup> Edition Chapter Images found on Jim's web site @ [www.jameshalderman.com](http://www.jameshalderman.com)**

**DOWNLOAD Chapter 120 Chapter Images: From [http://www.jameshalderman.com/automotive\\_principles.html](http://www.jameshalderman.com/automotive_principles.html)**

**NOTE: You can use Chapter Images or possibly Power Point files:**

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## Chapter 120 Steering Columns & Gears

### 1. SLIDE 1 CH120 STEERING COLUMNS & GEARS

Check for **ADDITIONAL VIDEOS & ANIMATIONS**  
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### **DISCUSS FREQUENTLY ASKED QUESTION:**

### **DISCUSS CASE STUDY:**

2. **SLIDE 2 EXPLAIN** **Figure 120-1** steering wheel assembly includes a driver's side air bag module plus many also include steering wheel controls.
3. **SLIDE 3 EXPLAIN** **Figure 120-2** The airbag inflates at the same time the driver moves toward the steering wheel during a front-end collision and supplements the protection of the safety belt.
4. **SLIDE 4 EXPLAIN** **Figure 120-3** The airbag module attaches to the steering wheel and is removed as an assembly to service the steering wheel and column

**Be careful! Airbags can inflate even if ignition is turned off & battery disconnected. Disconnect negative battery cable before removing airbag. You can damage spiral cable (SIR coil) by turning steering wheel when the column is disconnected from steering gear.**

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## Chapter 120 Steering Columns & Gears

**DEMONSTRATION: Show examples of airbag modules. Show the students how to identify vehicles with airbags**

5. **SLIDE 5 EXPLAIN FIGURE 120–4** Most vehicles have alignment marks made at factory on steering shaft and steering wheel to help the service technician keep steering wheel in the center position.
6. **SLIDE 6 EXPLAIN FIGURE 120–5** puller being used to remove a steering wheel after steering wheel retaining nut has been removed.
7. **SLIDE 7 EXPLAIN FIGURE 120–6** steering shaft links steering wheel the steering gear while column jacket, which surrounds part of shaft, holds support brackets and switches. This steering shaft has a small intermediate section between the main section and steering gear.

**EXPLAIN TECH TIP: *Locking Pliers to Rescue***

**Many vehicles use a jam nut on tie rod end. This jam nut must be loosened to adjust toe. Because end of tie rod is attached to a tie rod end that is movable, loosening nut is often difficult. Every time force is applied to the nut, the tie rod end socket moves and prevents full force of wrench from being applied to nut. To prevent this movement, simply attach locking pliers (Vise Grips®) to hold te tie rod. Wedge pliers against control arm to prevent any movement of tie rod. By preventing tie rod from moving, full force can be put on a wrench to loosen the jam nut without doing any harm to tie rod end.**

8. **SLIDE 8 EXPLAIN FIGURE 120–7** Pot joint is a flexible coupling used to join two shafts that allow plunging motion.
9. **SLIDE 9 EXPLAIN FIGURE 120–8** A typical intermediate steering shaft assembly showing a U-joint and related components
10. **SLIDE 10 EXPLAIN FIGURE 120–9** flexible coupling is used to isolate road noise and vibration from the steering shaft.
11. **SLIDE 11 EXPLAIN FIGURE 120–10** Steering column covers are often part of interior trim..

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## Chapter 120 Steering Columns & Gears

**DEMONSTRATION: Show examples of universal joints and pot joints used on steering columns**

**HANDS-ON TASK: Have the students identify the parts of steering column USING POST-IT NOTES**

**EXPLAIN TECH TIP: Do Not Pound on the Steering Column. Always use a steering wheel puller and/or special tools recommended by OEM when servicing steering column. If a hammer is used on steering shaft in an attempt to remove a steering wheel, the shaft could collapse, requiring the replacement of entire steering column assembly.**

12. SLIDE 12 **EXPLAIN** FIGURE 120–11 Collapsible steering columns include a mesh design that crushes easily, a bearing design that allows one section of column to slide into the other, and a breakaway device that separates the steering column from body of vehicle in the event of a front-end collision.
13. SLIDE 13 **EXPLAIN** FIGURE 120–12 Tilt mechanisms vary by design and OEM, although most use a ratchet to position the top portion of steering column.
14. SLIDE 14 **EXPLAIN** FIGURE 120–13 Typical steering column showing all of components from steering wheel to steering gear. Note that this column uses a column-type electric power steering system (EPS) and a tilt wheel.
15. SLIDE 15 **EXPLAIN** FIGURE 120–14 steering shaft splines onto steering wheel.
16. SLIDE 16 **EXPLAIN** FIGURE 120–15 toe plate seals the hole from the steering shaft and helps seal out noise and moisture.
17. SLIDE 17 **EXPLAIN** FIGURE 120–16 upper portion of steering column contains combination switch, often called multi-function switch used to control many functions.

**DEMONSTRATION: Show how to remove several types of column covers**

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## Chapter 120 Steering Columns & Gears

**HANDS-ON TASK:** Have the students remove column covers

**DISCUSSION:** Ask the students to discuss whether mesh-design collapsible steering column or bearing-design collapsible steering column is better

**DEMONSTRATION:** Show examples of breakaway support brackets and knee bolsters. Show examples of tilt mechanisms

When replacing wires in steering column, make sure wires are placed in wire trough. This will prevent damage to wires.

When changing turn signal switches, attach a snake wire (a piece of wire used to pull new wires) to switch wires at base of steering column. As old switch is removed, snake wire will be pulled up through column. The snake wire can now be used to pull new switch wires in place.

### **ON-VEHICLE ASE EDUCATION TASK B6:**

Inspect steering shaft universal-joint(s), flexible coupling(s), collapsible column, lock cylinder mechanism, and steering wheel; determine needed action.

18. SLIDE 18 **EXPLAIN** FIGURE 120–17 upper section of the steering column contains the steering shaft bearing.
19. SLIDE 19 **EXPLAIN** FIGURE 120–18 lock plate engages an ignition lock pawl to keep steering wheel in one position when the ignition is off.

**DISCUSSION:** Ask the students to discuss whether a 22:1 steering gear ratio or a 14:1 steering gear ratio is better

20. SLIDE 20 **EXPLAIN** FIGURE 120–19 As steering wheel is turned, nut moves up or down on threads, shown using a bolt to represent worm gear and nut representing the gear nut that meshes with teeth of sector gear.
21. SLIDE 21 **EXPLAIN** FIGURE 120–20 Steering gear ratio is ratio between number of degrees steering wheel is rotated to number of degrees front wheel turns..

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QUESTION



## Chapter 120 Steering Columns & Gears

22. SLIDE 22 **EXPLAIN** FIGURE 120–21 Constant-ratio steering gear sector shaft. Notice that all three gear teeth are the same size.

**ON-VEHICLE ASE EDUCATION TASK B1:**  
**Disable and enable supplemental restraint system (SRS); verify indicator lamp operation.**

**ON-VEHICLE ASE EDUCATION TASK B2:**  
**Remove and replace steering wheel; center/time supplemental restraint system (SRS) coil (clock spring).**

**DEMONSTRATION:** Show examples of constant ratio steering gear sector shafts and variable-ratio steering gear sector shafts

**DEMONSTRATION:** Show the students examples of typical manual recirculating ball steering gears.

23. SLIDE 23 **EXPLAIN** FIGURE 120–22 Variable-ratio steering gear sector shaft. Notice larger center gear tooth.

**DISCUSSION:** Have a discussion of problems with upper and lower bearings

24. SLIDE 24 **EXPLAIN** FIGURE 120–23 sector gear meshes with gear teeth on ball nut.

25. SLIDE 25 **EXPLAIN** FIGURE 120–24 A typical manual recirculating ball steering gear.

26. SLIDE 26 **EXPLAIN** FIGURE 120–25 sector shaft is supported by bushings, one in housing and one in side cover.

27. SLIDE 27 **EXPLAIN** FIGURE 120–26 Worm bearing preload is a turning force measured in inch-pounds or Newton-meters and worm endplay is axial movement measured in fractions of an inch or millimeters.

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## Chapter 120 Steering Columns & Gears

**DEMONSTRATION:** Show how to use a beam-type inch-pound torque wrench to perform an overcenter adjustment. Show how to adjust worm bearing preload by installing selectively sized shims. Show how to use a spanner wrench and a ruler or tape measure to adjust worm gear freeplay.

**HANDS-ON TASK:** Have the students adjust worm gear freeplay

28. **SLIDE 28 EXPLAIN FIGURE 120–27** The first step to adjust worm gear freeplay is to bottom the worm gear nut, using a spanner wrench designed to fit into the two holes in the nut.
29. **SLIDE 29 EXPLAIN FIGURE 120–28** After worm gear nut has been tightened, measure 1/2 inch (13 mm) and mark the case. Using spanner wrench, rotate worm gear nut counterclockwise 1/2 inch, align the marks, and then tighten the retaining nut. This procedure gives proper worm gear endplay.

**ON-VEHICLE TASK:** Adjust non-rack and pinion worm bearing preload and sector lash; Remove and replace rack and pinion steering gear

30. **SLIDE 30 EXPLAIN FIGURE 120–29** Performing an overcenter adjustment requires use of a beam-type inch-lb torque wrench. After worm bearing preload procedure has been completed, use torque wrench to measure rotating torque, which should be 6- to 15 inch-pounds. If rotating torque is within specified range, adjust overcenter adjustment screw until you achieve 6- to 10 inch-pounds more rotating torque and then tighten retaining nut.
31. **SLIDE 31 EXPLAIN FIGURE 120–30** Sector shaft endplay is the measurement of how far the sector shaft can move axially and is measured in fractions of an inch or millimeters.

**Rack and Pinion Steering (View)**  
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## Chapter 120 Steering Columns & Gears

**DEMONSTRATION: Show components of a typical manual rack-and-pinion steering gear.**

**DISCUSSION: Ask the students to discuss whether a rack and-pinion steering gear or a conventional steering gear is better**

32. **SLIDE 32 EXPLAIN FIGURE 120–31** Rack-and-pinion steering gear operation is simple, direct, and the rack is in a straight line to the front wheels..
33. **SLIDE 33 EXPLAIN FIGURE 120–32** A typical manual rack-and-pinion steering gear used in a small front-wheel-drive vehicle.
34. **SLIDE 34 EXPLAIN FIGURE 120–33** spring-loaded rack support positions rack to keep it from rubbing against the housing and establishes pinion torque..
35. **SLIDE 35 EXPLAIN FIGURE 120–34** A small air tube is used to transfer air between the boots as they extend and compress during turns.
36. **SLIDE 36 EXPLAIN FIGURE 120–35** This manual rack-and-pinion steering gear mounts to the bulkhead (firewall), whereas others mount to the engine cradle or frame of the vehicle.
37. **SLIDE 37 EXPLAIN Figure 116-36** Pinion torque is a turning torque force measured in inch-pounds or Newton-meters. Tightening the rack support against the rack increases the pinion torque.
38. **SLIDE 38 EXPLAIN FIGURE 120–37** Pinion bearing preload is a measurement of turning force required to overcome the resistance of the pinion shaft bearings.
39. **SLIDE 39 EXPLAIN FIGURE 120–38** To adjust the rack-and-pinion gear preload, loosen the retaining nut and tighten the adjuster nut until it bottoms. Then loosen 60 degrees (one “flat” of the six-sided retainer). Tighten retaining nut.

**DEMONSTRATION: Show how to adjust the rack-and pinion gear preload: FIGURES 120-37, 38**