Automotive Electrical & Engine Performance 8/E

Chapter 17 Cranking System

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Electrical & Engine Performance 8th edition provides complete coverage of automotive areas pertaining vehicle electrical systems and engine performance. 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, and Animations that are listed in this Lesson Plan. This Lesson Plan also references ASEEducation (NATEF) Task Sheets available from Jim's web site.
Motivate Learners	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.
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.	Explain the chapter learning objectives to the students. 1. Describe the parts and operation of a cranking circuit and explain computer-controlled starting. 2. Discuss how a starter motor converts electrical power into mechanical power. 3. List the different types of starters. 4. Describe gear reduction starters and the function of starter drives. **Repair).This chapter will help you prepare for the ASE Electrical/Electronic Systems (A6) certification test content area "C" (Starting System Diagnosis and Repair).**
Establish the Mood or Climate	Provide a *WELCOME,* Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	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: This lesson plan is based on Automotive Electrical & Engine Performance 8th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 17 Chapter Images: From

http://www.jameshalderman.com/books_a8.html#anchor2

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1. SLIDE 1 CH17 Cranking System

Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/

WEB SITE IS CONSTANTLY UPDATED

At the beginning of this class, you can download the crossword puzzle & Word Search from Jim's web site to familiarize your class with terms in this chapter & then discuss them, see below:

HTTP://WWW.JAMESHALDERMAN.COM/BOOKS_A8.HTML#ANCHOR2

DOWNLOAD

CROSSWORD PUZZLE (MICROSOFT WORD) (PDF)

WORD SEARCH PUZZLE (MICROSOFT WORD) (PDF

Videos

Starter Circuit (View) (Download)
Starter Circuit Neutral Safety Switch (View) (Download)
DC Motor (View) (Download)

2. **SLIDE 8** EXPLAIN **Figure 17-1** typical solenoid-operated starter.
3. **SLIDE 9** EXPLAIN **Figure 17-2** Some column-mounted ignition switches act directly on the electrical ignition switch itself, whereas others use a link from the lock cylinder to the ignition switch.
4. **SLIDE 4** EXPLAIN **Figure 17-3** To prevent engine from cranking, an electrical switch is usually installed to open circuit between ignition switch & starter solenoid.

DISCUSSION: Have the students discuss difference between engine cranking and engine starting. What is required for an engine to start?

HANDS-ON TASK: Have half the students locate and label system components with numbers. Have other half identify the components by number.

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5. **SLIDE 5 EXPLAIN Figure 17-4** Instead of using an ignition key to start engine, some vehicles are using a start button which is also used to stop engine
6. **SLIDE 6 EXPLAIN Figure 17-5** top button on this key fob is the remote start button.
7. **SLIDE 7 EXPLAIN Figure 17-6** series-wound electric motor shows the basic operation with only two brushes: one hot brush and one ground brush. The current flows through both field coils, then through the hot brush and the loop winding of the armature, before reaching ground through the ground brush.
8. **SLIDE 8 EXPLAIN Figure 17-7** interaction of the magnetic fields of armature loops and field coils creates a stronger magnetic field on right side of conductor, causing the armature loop to move toward left.

DISCUSSION: Have the students discuss the principles of magnetism. What causes a stronger magnetic field?

DEMONSTRATION: Use two bar magnets to show the students how like magnetic charges repel while opposite charges attract.

9. **SLIDE 9 EXPLAIN Figure 17-8** armature loops rotate due to the difference in the strength of the magnetic field. The loops move from a strong magnetic field strength toward a weaker magnetic field strength.
10. **SLIDE 10 EXPLAIN Figure 17-9** Magnetic lines of force in a four-pole motor.
11. **SLIDE 11 EXPLAIN Figure 17-10** pole shoe/field winding
12. **SLIDE 12 EXPLAIN Figure 17-11** This wiring diagram illustrates the construction of a series-wound electric motor. Notice that all current flows through the field coils, then through the armature (in series) before reaching ground.
13. **SLIDE 13 EXPLAIN Figure 17-12** This wiring diagram illustrates the construction of a shunt-type electric motor, and shows the field coils in parallel (or shunt) across the armature.

DISCUSSION: Have students discuss principle of CEMF (Counterelectromotive Force).
How is torque of a shunt motor affected by CEMF?

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DISCUSSION: Have students discuss characteristics of a series motor. What is relationship between the strength of magnetic fields and Starter torque?

14. **SLIDE 14 EXPLAIN Figure 17-13** A compound motor is a combination of series and shunt types, using part of the field coils connected electrically in series with the armature and some in parallel (shunt).
15. **SLIDE 15 EXPLAIN Figure 17-14** A typical starter motor showing the drive-end housing.
16. **SLIDE 16 EXPLAIN Figure 17-15** Pole shoes and field windings installed in the housing.
17. **SLIDE 17 EXPLAIN Figure 17-16** A typical starter motor armature. The armature core is made from thin sheet metal sections assembled on the armature shaft, which is used to increase the magnetic field strength.
18. **SLIDE 18 EXPLAIN Figure 17-17** armature showing how its copper wire loops are connected to the commutator.
19. **SLIDE 19 EXPLAIN FIGURE 17–18** A cutaway of a typical starter motor showing the commutator, brushes, and brush spring.

EXPLAIN TECH TIP: *Don't Hit That Starter!*

In the past, it was common to see technicians hitting starter in their effort to diagnose a no-crank condition. Often shock of blow to starter aligned or moved brushes, armature, and bushings. Many times, starter functioned after being hit, even if only for a short time. However, most starters today use permanent magnet fields, and the magnets can be easily broken if hit. A magnet that is broken becomes two weaker magnets. Some early permanent magnet starters used magnets that were glued or bonded to the field housing. If struck with a heavy tool, the magnets could be broken with parts of the magnet falling onto armature and into the bearing pockets, making starter impossible to repair or rebuild. • SEE FIGURE 17–19.

20. **SLIDE 20 EXPLAIN Figure 17-19** This starter permanent magnet field housing was ruined when someone used a hammer on the field housing in an attempt to "fix" a starter that would not work

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HANDS-ON TASK: Have the students disassemble a starter motor to inspect its components

21. **SLIDE 21 EXPLAIN FIGURE 17–20** A typical gear-reduction starter..
22. **SLIDE 22 EXPLAIN Figure 17-21** cutaway of a typical starter drive showing all of the internal parts.

DISCUSSION: Have the students discuss gear-reduction starters. What is the purpose of a gear reduction starter? Have the students discuss how gear reduction starter construction differs from that of traditional starter motors.

23. **SLIDE 23 EXPLAIN FIGURE 17–22** The ring gear to pinion gear ratio is usually 15:1 to 20:1.

Starter Drive Gear (View) (Download)

24. **SLIDE 24 EXPLAIN Figure 17-23** Operation of the overrunning clutch. (a) Starter motor is driving the starter pinion and cranking the engine. The rollers are wedged against spring force into their slots. (b) The engine has started and is rotating faster than the starter armature. Spring force pushes the rollers so they can rotate freely.

DISCUSS FREQUENTLY ASKED QUESTION:

What Is a Bendix? **Older-model starters often used a Bendix drive mechanism, which used inertia to engage starter pinion with engine flywheel gear. Inertia is tendency of a stationary object to remain stationary, because of its weight, unless forced to move. On these older-model starters, small starter pinion gear was attached to a shaft with threads, and weight of this gear caused it to be spun along the threaded shaft and mesh with flywheel whenever starter motor spun. If engine speed was greater than starter speed, pinion gear was forced back along threaded shaft and out**

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of mesh with flywheel gear. The Bendix drive mechanism has generally not been used since the early 1960s, but some technicians use this term when describing a starter drive.

DEMONSTRATION: Show students how to bench test a starter motor to check for proper operation.

25. **SLIDE 25 EXPLAIN FIGURE 17–24** Wiring diagram of a typical starter solenoid. Notice that both the pull-in winding and the hold-in winding are energized when the ignition switch is first turned to the "start" position. As soon as the solenoid contact disk makes electrical contact with both the B and M terminals, the battery current is conducted to the starter motor and electrically neutralizes the pull-in winding.

DISCUSS FREQUENTLY ASKED QUESTION:

How Are Starters Made So Small? **Starters and most components in a vehicle are being made as small and as light in weight as possible to help increase vehicle performance and fuel economy. A starter can be constructed smaller due to the use of gear reduction and permanent magnets to achieve the same cranking torque as a straight drive starter, but using much smaller components. • SEE FIGURE 17–25 for an example of an automotive starter armature that is palm-size.**

26. **SLIDE 26 EXPLAIN FIGURE 17-25** Palm-size starter armature.

27. **SLIDE 27 EXPLAIN FIGURE 17–26** Buick Auto Stop system lets the driver know when the engine is stopped.
28. **SLIDE 28 EXPLAIN FIGURE 17–27** Using two solenoids allows independent control of pinion gear and motor energization. This allows engine to be re-engaged (and re-started) by starter motor when engine RPM is falling from idle (about 600 RPM) to zero RPM. A tandem solenoid starter is almost identical in size and shape so it can be used on almost any engine.

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	DISCUSS FREQUENTLY ASKED QUESTION: ***Can a stop/start system be turned off?*** **Sometimes. Some vehicles equipped with a stop/start system can be turned off using a button on dash or center stack. ● SEE FIGURE 17–28.**
	29. SLIDE 29 EXPLAIN **FIGURE 52–28** stop/start system on this Ford F-150 pickup truck can be turned off using a switch on the dash.
Education Foundation	**Complete ASEEDUCATION Task A1: Research applicable vehicle and service information, such as electrical/electronic system operation, vehicle service history, service precautions, and technical service bulletins. (P-1)**
	HOMEWORK: SEARCH INTERNET: Ask students to research history of starter motor on the Internet. Ask them to identify the first car company to offer electric start, and when it was offered.