CRANKING SYSTEM

Figure 52-1 A typical solenoid-operated starter.

Figure 52-2 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.
Figure 52-3: To prevent the engine from cranking, an electrical switch is usually installed to open the circuit between the ignition switch and the starter solenoid.

Figure 52-4: Instead of using an ignition key to start the engine, some vehicles are using a start button which is also used to stop the engine, as shown on this Jaguar.

Figure 52-5: The top button on this key fob is the remote start button.
Figure 52-6  This 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.

Figure 52-7  The interaction of the magnetic fields of the armature loops and field coils creates a stronger magnetic field on the right side of the conductor, causing the armature loop to move toward the left.

Figure 52-8  The 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.
Figure 52-9 Magnetic lines of force in a four-pole motor.

Figure 52-10 A pole shoe and field winding.

Figure 52-11 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.
Figure 52-12  This wiring diagram illustrates the construction of a shunt-type electric motor, and shows the field coils in parallel (or shunt) across the armature.

Figure 52-13  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).

Figure 52-14  A typical starter motor showing the drive-end housing.
Figure 52-15 Pole shoes and field windings installed in the housing.

Figure 52-16 A typical starter motor armature. The armature core is made from the sheet metal sections assembled on the armature shaft, which is used to increase the magnetic field strength.

Figure 52-17 An armature showing how its copper wire loops are connected to the commutator.
Figure 52-18 A cutaway of a typical starter motor showing the commutator, brushes, and brush spring.

TECH TIP: Don’t Hit That Starter!

In the past, it was common to see service technicians hitting a starter in their effort to diagnose a no-crank condition. Often the shock of the blow to the starter aligned or moved the brushes, armature, and bushings. Many times, the 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 PM 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 the armature and into the bearing pockets, making the starter impossible to repair or rebuild. See Figure 52–19.

Figure 52-19 This starter permanent magnet field housing was ruined when someone used a hammer on the field housing in an effort to fix a starter that would not work. A total replacement is the only solution in this case.
Figure 52-20  A typical gear-reduction starter.

Figure 52-21  A cutaway of a typical starter drive showing all of the internal parts.

Figure 52-22  The ring gear to pinion gear ratio is usually 15:1 to 20:1.
Figure 52-23  Operation of the overrunning clutch. (a) Starter motor is driving the starter pinion that is engaging the engine. The rollers are engaged 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.

FREQUENTLY ASKED QUESTION

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

Figure 52-24 A Ford movable pole shoe starter.
Figure 52-25: 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 internal contact arm makes electrical contact with both the B and terminals, the battery current is conducted to the starter motor and electrically neutralizes the pull-in winding.

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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 52–26 for an example of an automotive starter armature that is palm size.

Figure 52-26: A palm-size starter armature.