STARTER BASICS

By: William C. "Bill" Anderson, P.E.

Reformatted for this website and published with the permission of *Old Cars Weekly*

The automobile electric starter developed in a few short months in the winter of 1910 and the spring of 1911 by Charles F. Kettering for its first commercial use in the 1912 Cadillacs is conceptually the same today. In the nearly 100 years since then there have been many refinements, but the basics remain the same.

An automobile electric starter is a high-torque, direct-current motor. It consists of a rotating armature, a pair of field coils, brushes and a commutator. The opposing magnetic forces in the armature and field coils convert electrical energy to mechanical energy. Kettering's insight leading to the starter's creation was that the starter needed to work very hard, but for only a brief period. Within that insight lies the most common abuse of starters — activating the starter for extended periods of time when the car engine won't start.

A relay is used to open the circuit enabling the large flow of electrical current required. The other essential components are the solenoid used to engage the starter drive to the ring gear on the flywheel and an over-running clutch which releases the starter drive when the engine starts. These basic components are depicted in Figure 1. Some starters, notably those used on some Chrysler products and imports, also include a gear reduction to increase cranking torque.

Figure 1

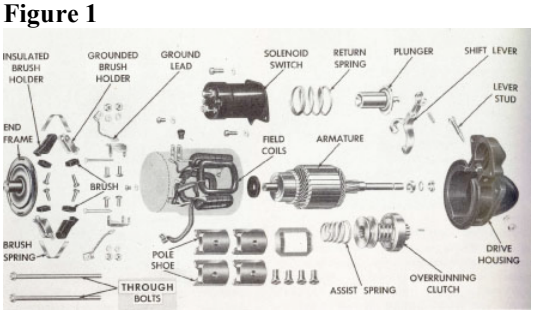

Figure 1 – Exploded view of a typical starter, a Delco-Remy unit is shown

Because starters are relatively simple and contain few parts, failure is rare. However, sub-standard performance is common with old starters or those which have been used extensively. The causes of poor performance are the same whether the starter is powered by 6-volts or 12-volts. However, the effects of a poorly-performing starter are more pronounced in 6-volt systems because they have only one-half the energy available in 12-volt systems.

It is also true that the starting demand on 6-volt starters is generally less than 12-volt starters because the compression ratio in the engines with 6-volt systems was typically 7:1 or less. The increase in compression ratios of engines in the late 1940s and early 1950s was the primary reason why 12-volt systems replaced 6-volt systems by the mid-1950s. Six-volt starters will effectively perform in their design applications if in good condition and supplied by good wiring and wiring connections.

Common Problems

The most common problems in the starting circuit and starter include in order of frequency include:

- Poor connections at the battery – corroded
- Poor ground connection at the engine
- Poor connection of the positive battery cable connection to the starter
- Worn commutator effectively raising the insulating mica separating the commutator segments (see Figure 2)
- Grease on the commutator
- Worn brushes
- Worn bushings allowing the starter shaft to move
- Short to ground in the field coils or armature
- Mechanical failure in the starter drive system

Figure 2

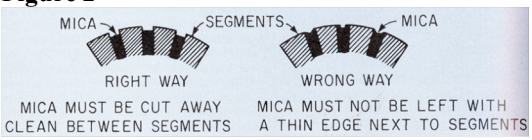

Figure 2 – Proper undercutting of commutator mica

Some cars will experience "heat soak" in which an elevated temperature of the starter created by hot engines and engine compartments increase the resistance in the windings. The increased resistance degrades the starter's ability to crank the engine. In severe cases, the engine will barely turn over.

Problem Diagnosis

Some tests of the starting system can be conducted on the car; others require taking the starter off and using special test instruments. If the starter will not turn the engine, turn on the headlights and then activate the starter. If the lights stay bright, there is an open circuit in the starter, the switch, or the starter main or control circuit. If the lights dim considerably, the battery may be run down or the starter may have a mechanical problem such as a jammed drive. If the lights go out, there is a bad connection in the main starter circuit.

If the battery is run down, it must be charged and the tests repeated. If conditions are unchanged once the battery is fully charged, the next step is to investigate connections in the main starter circuit. Poor connections are easy to fix by disconnecting each, thoroughly removing the corrosion and, then, reinstalling each tightly. The key rule for electrical connections is — Tight and Bright.

One other on car test is to bypass the starter circuit relay. If the starter operates when the relay is bypassed, the problem is in the relay or starter control circuit.

If problems remain, it is best to remove the starter for physical examination and bench testing. One test determines the no load speed and corresponding current draw. The other test is to determine the starter's torque when the armature is stalled. These test results must be compared to published specifications.

A low free speed and high current draw coupled with low torque can be caused by (a) dirty or worn bushings or bearings which allow the armature to drag on the pole shoes, (b) grounded armature or field coils, or (c) a shorted armature. If the free speed and torque are low

coupled with a low current draw there is an open field winding or there is high internal resistance. High resistance has many potential causes — poor connections, defective wiring, dirty commutator, worn brushes, worn commutator, broken or worn brush springs or anything else preventing good contact between the brushes and the commutator. Once all of the problems have been identified, the necessary repairs can be made.

Summary

The automobile starter is very robust unit and typically will perform for many years and many miles. However, over time their performance will degrade; this degradation is a bigger problem with 6-volt systems than 12-volt systems. The only way to properly ascertain a starter's capability is with the bench testing described in this article. For most collector cars, a properly rebuilt starter coupled with good wiring and connections will assure effective performance. For 6-volt systems, I always also include high torque field coils in all rebuilt starters.

A final caution – If the engine will not start, do not keep running the starter. Use it for a few seconds (no more than 20) and then give it a break to cool before trying again to start the engine again. Long periods of activation generate lots of heat and lead to premature starter failure.