Diagnosing solenoid magnetic imbalance

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One of the questions I am asked about starters is "what causes a starter to stay engaged after the engine starts?"

There could be many reasons, but one that is frequently overlooked and easily checked is *solenoid magnetic imbalance.* What is that? First let's discuss the operation of a solenoid.

When the ignition switch is closed, current flows through the "pull-in" coil to ground through the starter armature. Current also flows through the "hold-in" coil directly to ground.

As the plunger moves, it presses the contact disk across the battery and starter contact posts allowing cranking current to flow to the armature. This also places battery potential on both ends of the "pull-in" coil so that no current flows through it. Current continues to flow through the "hold-in" coil to ground.

When the motor starts and the ignition switch is opened, the contact disk is still momentarily connected across the battery and starter contact posts. Current now flows from the starter contact post through the "pull-in" coil in the opposite direction and to ground in series through the "hold-in" winding in the same direction as it originally flowed. When current flows through a winding in the opposite direction, the magnetic field lines of flux will also be in the opposite direction.

This creates a cancellation of the two magnetic fields ("pull-in" and "hold-in") allowing the plunger spring to release the contact disk. If the two windings are not in magnetic balance the magnetic fields will not cancel each other and the stronger of the two (if greater than the return spring pressure) will retain the contact disk and plunger causing the starter to stay engaged in the flywheel.

Generally, what causes magnetic imbalance is shorted turns in one winding. The strength of a magnetic field is dependent on the ampere-turns ratio. In other words, magnetic field strength can be increased or decreased by changing the amount of current which flows through a winding or by changing the number of turns. It is very difficult to detect shorted turns via resistance measurement because the change in resistance which can create magnetic imbalance may not be detectable with normal shop instruments.

So how do I check for magnetic imbalance? The procedure is simple, you need a 12 volt battery and some good jumper wires. The diagram above shows how to do this on a typical solenoid.

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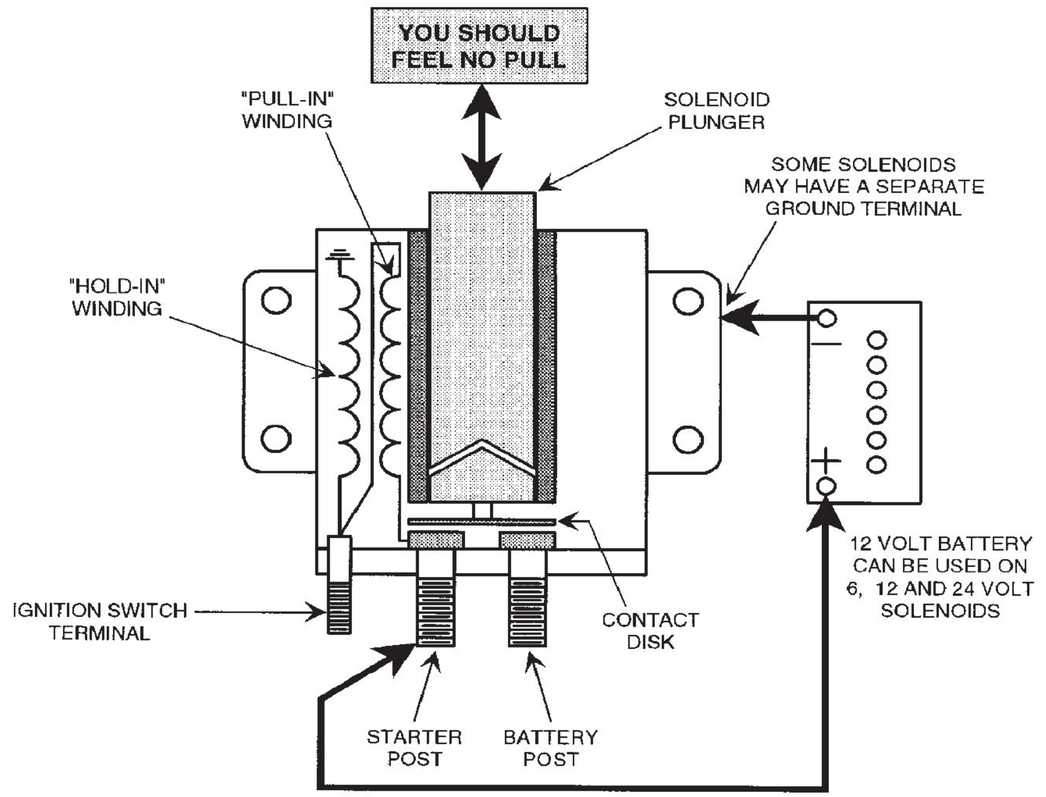
CHECKING SOLENOIDS FOR MAGNETIC IMBALANCE

1. CONNECT SOLENOID TO A 12 VOLT BATTERY AS SHOWN, THERE SHOULD BE NO PULL ON THE PLUNGER. THE DRAWING IS NOT INTENDED TO PHYSICALLY DEPICT ANY PARTICULAR SOLENOID BUT RATHER TO SHOW THE GENERAL ELECTRICAL CONNECTIONS.
2. IF THERE IS NO PLUNGER PULL THEN PERFORM THE FOLLOWING TESTS USING YOUR NORMAL TEST PROCEDURES:
   A. MEASURE "PULL-IN" AND "HOLD-IN" CURRENT
   B. VOLTAGE DROP UNDER LOAD ACROSS CONTACT DISK
   C. GENERAL PHYSICAL AND MECHANICAL CONDITION.



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