



SOLENOIDS & SWITCHES

Solenoids

Webster's Collegiate Dictionary defines a solenoid as "a coil of wire usually in cylindrical form, that when carrying a current, acts like a magnet so that a movable core is drawn into the coil when a current flows, and that is used especially as a switch or a control for a mechanical device".

The most common solenoids used in automotive starters are made by winding two coils of wire on a common bobbin. When current is passed through the wire an electromagnet is created. This in turn causes a steel core to move.

These two coils, a pull in and a hold in coil, each have a specific make up and function. They share a common feed point but separate ground termination points.

The pull in coil is made of a heavy gauge wire and terminates at the field connection "Motor Stud". This coil has a high amperage draw and creates a strong magnetic field. It's primary function is to induce enough force on the moveable core "Plunger" to shift the starter drive into the ring gear. When the switch contacts close, they carry current to the motor stud. At this point, the motor stud becomes a live terminal and cancels out the ground for the pull in coil. This eliminates it's draw and makes the amperage it was using available for cranking.

The hold in coil is made of a lighter gauge wire and terminates to a case ground, or in the case of an insulated solenoid such as a 40 or 42 MT, to a ground stud. It's primary function is to hold the movable core in place while the starter is working.

The coils are wound parallel, and when current is applied to the common feed terminal, both exert a same direction magnetic field on the plunger.

When power is removed from the feed terminal a reverse flow of current begins at the motor stud, and travels through the pull in coil to the feed terminal, then on through the hold in coil to ground. This creates two opposing magnetic fields that cancel each other out. This allows the drive to disengage from the ring gear.

The coils must be balanced so that one does not overpower the other and cause the plunger to hang up and keep the drive engaged.

Switches

Webster defines a Switch as “a device for making, breaking, or changing the connections in an electrical current.”

The switch portion of our solenoids consist of the moving contact and the stationary studs.

The moving contact is mounted on a spring loaded stem and when shifted by the plunger, is used to bridge the stationary studs. The moving contact has to carry full battery current to the starter motor. The initial contact produces a heavy arc and heat caused by resistance. Additional circuits, such as a relay terminal, are used to switch battery voltage to secondary loads during cranking only. These “R” terminals can be used to feed ignition coils, cold start injectors, and fuel pumps.

Common Problems...some common problems, causes & cures

Chatter-Solenoid chatter or rapid licking can have several causes:

- 1 Faulty Hold In Coil.** The hold in coil may not have a solid ground. It may have a break in the coil or a poor connection to the feed terminal. This can be checked by testing from the feed terminal to the case of the solenoid or to the ground stud of insulated circuit units. An amperage load test will give the best results.
- 2 Poor Connections.** An insufficient system ground, loose, dirty or corroded feed wires, may provide enough of a circuit to energize the solenoid, but when the heavy draw of the starter kicks in the ground or feed can be lost and the solenoid drops out. As soon as the contact break, the circuit reconnects and the solenoid pulls back in and the process repeats. Voltage drop testing will locate this type of a problem.
- 3 Low Battery.** Batteries with bad internal connectors, dirty jumpers or undercharged will not be able to supply sufficient voltage to keep the solenoid engaged once the starter load is placed on the system. Battery voltage should be check at the batteries while the starter is activated. Six volt batteries that are hooked in series should be tested individually and as a bank. This will qualify the jumper connection.
- 4 Faulty Starter.** A shorted or mechanically bound starter may cause enough of a voltage drop to cause the solenoid to kick out. Be sure that the starter will free spin independent of the solenoid.

Click

- 1 Damaged Contacts.** A dirty, burned, oxidized or corroded studs or moving disk. A weak contact spring or sticking insulator can cause a click but no crank condition. Check for voltage drop across the solenoid studs.
- 2 Faulty Starter.** In many cases the same problems that cause chatter will cause a clicking problem.
- 3 Plunger Problems.** A worn, dirty, or corroded plungers may not be able to complete their travel inside of the sleeve.
- 4 Pinon Problems.** An improperly set pinion stop can limit the travel of the plunger. Be sure to set all pinions to specifications. A too tight pinion bushing or a bent shaft may cause this problem as well.
- 5 Shift Lever Problems.** A bent, twisted, or bound shift lever can also impede the travel of the plunger. Many shift levers are designed to be installed in only one direction. Be sure to note the position of the shift lever during tear down.

SOLENOID REBUILDING

Rebuilding/Remanufacturing/Reconditioning

Rebuilding or remanufacturing requires the complete disassembly of a solenoid, replacement of all wear components, and the rewinding of the coil if necessary. Reconditioning may consist of a basic coil test and the cleaning or replacement of contacts. Each rebuilder has their own quality benchmarks.

In order to produce an acceptable rebuilt/reconditioned solenoid, the rebuilder has to follow good basic rebuilding guidelines, as well as, making many judgement calls. The most important step is deciding if a core should be rebuilt.

START WITH A GOOD QUALITY CORE!!!!

Today there seems to be as many manufacturers of solenoids as there are brands of beer. As we know, some are better than others. OEM solenoids are the best to rebuild. Here are some simple rules to follow.

- **Do not rebuild a solenoid that you would not use from the manufacturer.**
- **Qualify all components, even the new parts.**
- **Do not mix components between manufacturers.**
- **Watch for variations within a manufacturers line.**
- **Know what your standards are.**
- **Use the proper tools and equipment**
- **Clean and insulate properly. Internal connections are as important as those on the vehicle.**
- **Test, test & retest**
- **Testing and qualifying all components and subassemblies during the rebuilding process will help to assure a high quality finished product.**
- **Test coils for proper amperage draw, balance, integrity of insulation and tightness of wrap.**
- **Inspect ground wire connections.**
- **Test springs for proper tension.**
- **Inspect sleeve for damage.**
- **Check all insulator for damage.**
- **Inspect the can, inside and outside.**

Rebuilding Steps..parts can cost less than \$2.00:

- 1 **Test** - is it worth rebuilding
- 2 **Disassemble** - (open up the can) Press the coil and cap assembly out of the can
- 3 **De-solder** - de-solder the coil from the can and test the coil.
- 4 **Clean** - caps can be reused if contacts are replaced
- 5 **Test**
- 6 **Reassemble & Press** can over cap
- 7 **Test**

TECH TIPS

Delco 10-27MT Industrial Starters

Using a heavy duty 132 wind solenoid, on all starters that have a large body drive, will greatly improve the overall performance. The stronger coil will help to give positive drive engagement and ensure that the contact are fully closed. The coil strength can be tested magnetically.

Bosch Industrial Starters

Bosch not only has three different types of moving contacts in the industrial "402" type solenoid, but also uses a variety of different plungers. Be sure to match the plunger style and length to the solenoid and to the starter application.

Bosch Automotive Starters

Bosch "303" type solenoids come in a standard and heavy duty version. The heavy duty type uses a thicker can wall and a smaller coil bobbin. Care must be taken to match coils to cans. A heavy duty coil will fit into a standard can, but because of the additional air gap, will not work properly. As with their industrial units, Bosch also uses different plungers for different starters. Overall length as well as the shift fork hold can vary. There are also different bolt patterns on some of these solenoids.

Bosch "302" type solenoids have a variety of plunger lengths and shift fork hole sizes.

Hitachi

Crimp cap Hitachi solenoids have numerous lengths of shift lever support springs. Be sure to match replacements to the OEM.

24V Hitachi solenoids used on industrial applications will often have brass or steel plated studs.

Industrial solenoids may have a flat bottom plunger rather than the typical concaved type. They are not interchangeable.

Mitsubishi

Mitsubishi automotive type solenoids have many different stem lengths on the moving contact. The plunger used, must be matched to the contact used.

Industrial starters such as the Lester #17037 have two different length solenoids and they use different plungers. Be sure to match them.

The package of spacer shims found with many Mitsubishi solenoids are not a packaging error. The shims are used to adjust pinion clearance.

Nippondenso

Some large Nippondenso starters use a shunt coil in the starter as part of the solenoid circuit. If this coil shorts, it will cause a malfunction of the solenoid.

Nippondenso Gear Reduction Starters that have worn contacts should have the coils removed and inspected.

When the contacts fail, the starter will try to draw starting current through the switch terminal and coil wires.

This is very common on industrial and late silver body starters.

Nikko/28MT

There are two different versions of a four terminal cap used on Nikko/Delco 28MT. One is a normal "R" terminal, while the other is a dummy.

Special Note

Always check the ground connections.

**Special Thanks to
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