

Solenoids & Their Peculiarities

IN THIS ISSUE WE WOULD LIKE to talk about how to diagnose and solve a few common solenoid-related problems. We would also like to review some unusual things you may run into with certain types of solenoids. For general information about solenoid operation, see *Technical Update 33* (November 1996).

Problem: "Click-click" condition

If the solenoid clicks but the starter motor doesn't turn, you may have one of several different problems -- some of which are not in the solenoid.

Open condition. If you get a "click-click," there

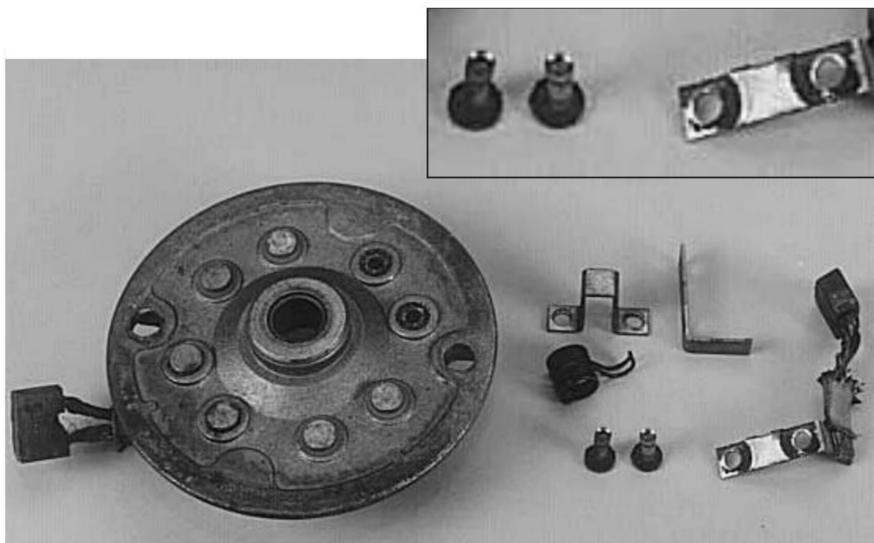


Figure 1. Note corrosion on aluminum C.E. cap, ground-brush bracket and rivets (inset).

may be an open condition somewhere in the pull-in circuit. This "open" may be in the pull-in winding itself, in the field coil or brushes, or in a poor connection where the armature hairpins are connected to the commutator bar. It might also be caused by a poor connection anywhere in that circuit.

In the cases of some Paris Rhone and some Lucas starters, an open condition can be caused by corrosion buildup between the steel brush holder, copper brush leads, and aluminum C.E. cap/plate. In these starters the ground brush and brush holder are riveted to the C.E. cap/plate and the corrosion often can't be seen until you remove the rivets (*Figure 1*).

On Ford PMGR and other starters, high resistance in the ground-brush circuit can also cause an open

condition. Note in *Figure 2* that one small screw attaches the ground brush to the C.E. plate. If there is resistance between the screw head and C.E. plate or the C.E. plate and ground-brush bracket, it will cause a "click-click" condition. This resistance can be caused by corrosion or simply too much paint.

Problem in indexing mechanism. You can also get a "click-click" condition if the gear is stuck or slow to move back on the drive shaft or the armature shaft. It can also occur if the collar on the drive won't move, or if the indexing spring is too strong.

Out of adjustment. Finally, if the solenoid is out of adjustment in relation to the drive, the drive can come

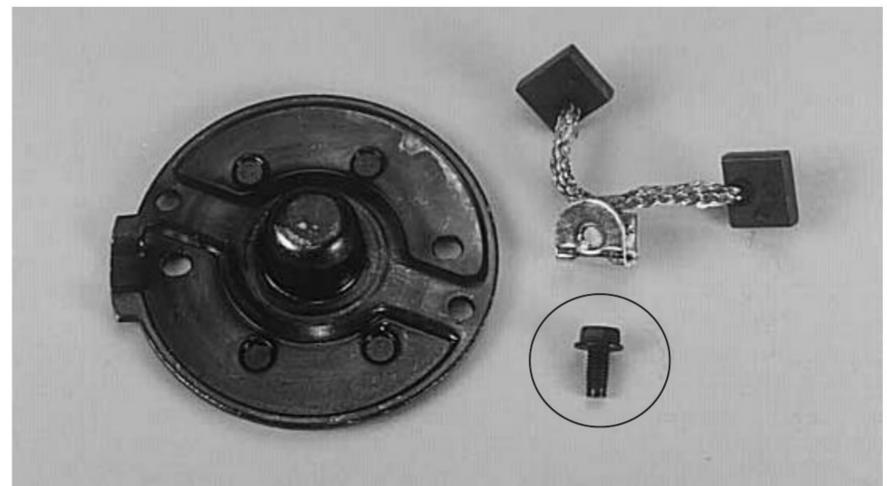


Figure 2. On Ford PMGR and other starters, corrosion or paint between the C.E. plate and the screw that attaches the ground brush to the C.E. plate can cause a "click-click" condition.

in contact with the stop collar before the solenoid contacts close. This can also cause the solenoid to click without the starter motor cranking.

Problem: Milling condition

In these cases the starter motor turns, but the teeth of the drive slide over the teeth of the flywheel, making a terrible noise. This condition can be caused by any of several different things.

Problem in indexing mechanism. You can get milling if the gear is stuck or slow to move forward on the drive shaft or the armature shaft. This condition can also occur if the collar on the drive won't move or the indexing spring is too weak.



Out of adjustment. If the solenoid is out of adjustment in relation to the starter drive so the solenoid contacts close before the drive is engaged with the flywheel, you will also get a milling condition.

Problem: Nothing happens

One of the reasons for this problem is “heat soaking” of the solenoid. A solenoid is said to be heat soaked if it is so overheated that the resistance of the windings does not allow enough current flow for the solenoid to operate. However, a couple of other things can also cause the solenoid to be completely dead.

High voltage drop. There may be too much voltage drop to the S-terminal. This can come from high resistance in the vehicle wiring or high resistance across one or more switches (ignition switch, neutral safety switch, clutch safety switch, etc.).

Plunger too far out. In other cases the plunger may have moved so far out of the bore that it is extremely hard to pull it back in. This can happen if something is bent or out of adjustment.

Problem: Solenoid kicks in and out rapidly (machine-gun noise)

Poor ground. Most of the time the hold-in winding in the solenoid is spot-welded to a steel plate. If this wire is broken or the plate does not make a good ground to the case of the solenoid, the solenoid will be operating only on the pull-in winding. Because the pull-in winding loses its magnetism as soon as the contacts close between the battery terminal and motor terminal, the plunger returns to its stationary position and the contacts open. But because the ignition switch is still in the cranking position, current starts to flow again in the pull-in winding, which pulls the plunger in, closing the contacts again, and the whole procedure starts over. This causes a “machine-gun” noise as the solenoid kicks in and out.

Cap turned. If the solenoid cap is turned 180° so the terminals are opposite to where they should be, you can also get a machine-gun noise. In this case the windings that are normally terminated at the switch terminal are now connected to the motor terminal, and vice versa.

Bad battery. A bad or poorly charged battery can also cause a solenoid to kick in and out. Under these conditions the solenoid current flow lowers the already low battery voltage even further, which means the solenoid cannot stay engaged. But when the solenoid releases and the battery voltage goes back up, the solenoid engages and we start all over again. This also will cause a machine-gun noise as the solenoid kicks in and out.

Peculiarities of certain solenoids

Bosch

For Chrysler. In the three groups of Bosch starters for Chrysler shown in the chart below, different OE units interchange as complete units but have slightly different solenoids. (Some other parts differ as well.)

For example, in the chart you will note that there are four OE numbers under 2-1385-BO. Two of them use solenoid 66-9132 and one uses a 66-9182. The fourth starter (0-001-108-046), however, had two versions; Rev 1 used the 66-9132 and Rev 2 used the 66-9182. According to the bill of materials, the solenoid is the only

Solenoids for Bosch Starters for Chrysler		
2-1380-BO		
0-001-108-013	PMGR	66-9132
0-001-208-407	DD	66-9182
0-001-208-413	DD	66-9132
2-1385-BO		
0-001-108-032	PMGR	66-9132
0-001-108-045	PMGR	66-9132
0-001-108-046	PMGR	66-9132/66-9182
0-001-108-068	PMGR	66-9182
2-1387-BO		
0-001-108-066	PMGR	66-9132/66-9182
0-001-108-069	PMGR	66-9182
0-001-108-104	PMGR	66-9164
0-001-108-134	PMGR	66-9164
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0-331-303-020, 22		66-9132
0-331-303-108		66-9182
0-331-303-086,137		66-9164
2-339-303-208		66-9164
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66-9132, 66-9182	S-terminal	M4 x 0.7 Post
66-9164	S-terminal	M5 x 0.8 Post

part that has changed from Rev 1 to Rev 2.

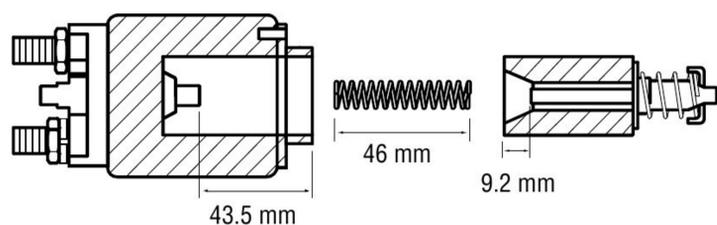
Potential for confusion arises because these two solenoids look alike and the pull-in and hold-in windings have the same resistance and amperage draw. However, it's important to know which solenoid you have because, using a Gauss meter, we found that the 66-9182 is approximately 20% stronger than the 66-9132. This means that if you use the 66-9132 in applications requiring the 66-9182, you're likely to have a click-click condition.

The fact that these starters have been in use since 1981 and many have been rebuilt in the past makes the situation even more complicated. Because the field cases are the same, some rebuilders are interchanging them. But, because the field case has the OE number stamped on it, this makes it very hard to determine which unit you actually have, and, therefore, which of these two solenoids to use. To be safe, we recommend that you use the 66-9182 on all these Bosch units for Chrysler.

Also note in the chart that solenoid 66-9164 has an M5 x 0.8 post-type S-terminal, and 66-9132 and 66-9182 have M4 x 0.7. Most rebuilders don't honor this difference and supply starters with the M4 x 0.7 post.

402 series. On Bosch 402 series solenoids (part numbers beginning with 0-331-402...), there are two types of movable-contact assemblies and plunger assemblies. The early-style solenoids use a 66-91701 movable-contact assembly and the later-style use a 66-91702.

Early style



Late style

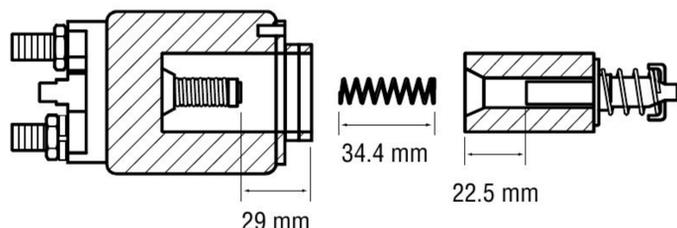


Figure 3. Bosch 402 series solenoids use two different movable-contact assemblies and plunger assemblies. These solenoids are interchangeable, but only as a complete assembly.

The two types of solenoids are interchangeable, but only as a complete assembly (solenoid, plunger and spring) (*Figure 3*).

Delco

Return springs. On Delco 5MT, 8MT, 10MT, 20MT, 22MT, 25MT, 27MT and 15GR, there are two possible plunger return springs. The 66-1551 short return spring is required for automotive applications because these starters are prone to heat-soak conditions. The 66-1553 long spring should be used for heavy-duty applications.

Delco PMGR & SD210/260. To ensure that plungers will not stick, Delco is now supplying a special grease that is applied to the first half-inch of the plunger bore (*Figure 4*). This grease was originally developed for use in Delco PMGR and SD210/260 applications, but can be used in other applications as well. Use of this grease is explained in GM Service Bulletin 338113, dated 11/93. The WAI part number for the grease is 89-273.

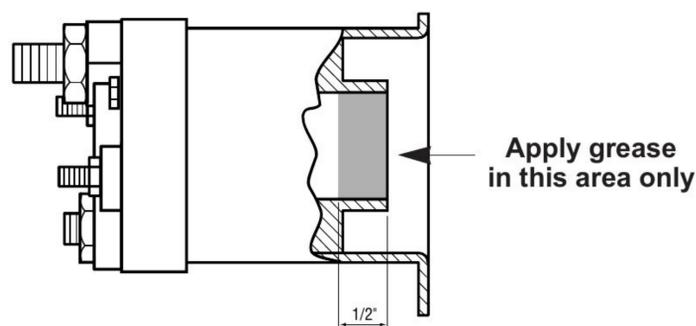


Figure 4. Special plunger grease is applied only to the first half-inch of the plunger bore in Delco PMGR applications. This grease can also be used in other applications as well.

PG260 Movable-contact replacement. Solenoids for Delco PG260 starters present some challenges when it comes to replacing the movable contact, so we thought it might be useful to explain the procedure. After removing the solenoid cap you'll see a washer just above the insulator for the movable contact. Push down on the movable contact, and with a pair of side cutters cut off the metal washer. Try not to destroy the small groove on the plunger stem. Replace the contact and insulator; then install an 84-8910 clip in place of the metal washer. *Note:* This also works for Mitsuba solenoids.

28MT. On two of the solenoids for 28MT starters, the R-terminal is a dummy, used to

attach a jumpstart-protection cap. These are the 12-volt 66-8406 (10457061 and 10457151) and the 24-volt 66-8407 (10457115 and 10457152).

37MT. On some solenoids for 37MT starters, the ground for the hold-in winding is external and goes through the shunt coils in the starter field case (*Figure 5*). If you are getting a kick-in/kick-out condition on these 37MTs, it may indicate an open condition in the shunt coil.

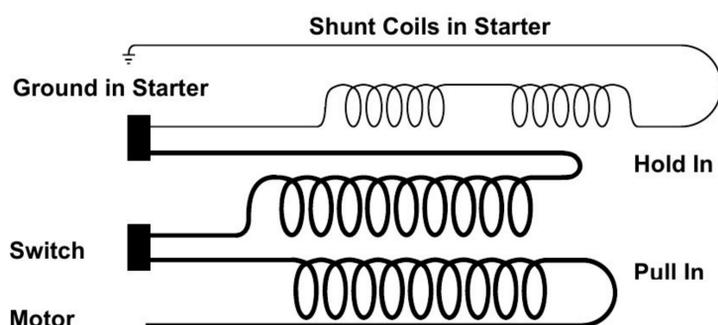


Figure 5. On some solenoids for Delco 37MT the ground for the hold-in winding is external.

On the other hand, if the starter is burning up the ignition or other switches, it could mean the shunt coil is drawing excessive amperage because it is shorted or grounded.

40MT & 42MT. Finally, you should note that Delco 40MT and 42MT starters have a thermal-protection switch. This switch, which is located in the C.E. cap, senses the temperature in the brush area. It is connected in series with the S-terminal. If the starter is overheated, the switch opens the circuit so the starter cannot crank. When the starter cools down, the contacts close again, allowing the starter to operate.

Ford

Movable-contact replacement. On solenoids for Ford, replacing the movable contact can be tricky, but we've found a way that works. After the cap is removed, support the solenoid body and use a small punch to push on the very tip of the movable-contact stem. This will roll up the riveted material that is holding the steel washer, the insulator and the contact onto the stem.

To reassemble, stack the replacement parts in the correct order, support the plunger (but NOT on the plastic tip), and peen over the material that was rolled up during disassembly.

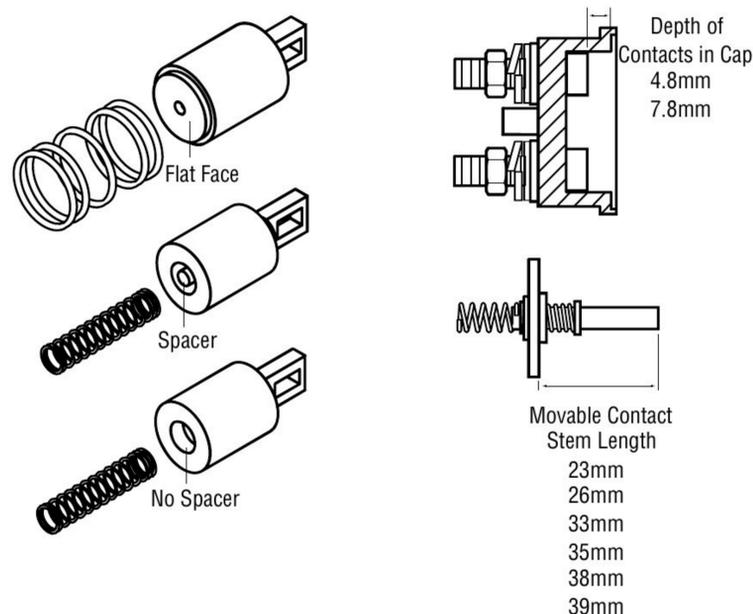


Figure 6. The different plunger assemblies, cap assemblies and movable-contact assemblies on “crimp cap” solenoids for Mitsubishi are not interchangeable, although the solenoids themselves are interchangeable as complete assemblies.

Mitsubishi

“Crimp cap” solenoids. The “crimp cap” solenoids for Mitsubishi have undergone some design changes that may raise some questions when you start to rebuild them. Within a given solenoid part number, the different solenoid designs are interchangeable as a complete assembly (including the plunger). However, the different components are NOT interchangeable. So when you are rebuilding these solenoids, it is very important to keep all the mating parts together (cap assembly, movable-contact assembly, plunger spring and plunger).

As you can see in *Figure 6*, these solenoids use three different plunger assemblies. In addition, some of the cap assemblies look alike, except for the depth from the end of the cap to the surface of the stationary contact. The length of the movable-contact stem also varies, as shown in *Figure 6*. To determine the correct length of this stem, measure from the end of the stem to the underside of the movable contact.

Watch for Technical Update 35 for a continuation of our discussion of solenoids, featuring Hitachi, Lucas M50, Nippondenso and starters with sliding armatures.