DENSO'S PMGR STARTER
Unique Flat Commutator



BY BOB THOMAS

Back in 2003 Denso introduced a different automotive starter for gasoline engines up to 3.5 liters. Utilizing rare-earth permanent magnets and a planetary gear reduction arrangement, these starters were a departure from the series motor, off-set gear reduction design that had defined the Japanese manufacturer since the1980's (*see Figure 1*).

This new PMGR starter produced 1.6 kW of power in a smaller and lighter package than anyone had ever done before. In the field now for over ten years, these starters are reaching their normal end of life, requiring a need to be serviced or replaced.

There are five known Lester numbers that cover this series of starters. The 17825, 17956 and 17955 starters are all CCW rotation. Their applications include Toyota Camry, Lexus ES300, Scion tC, Subaru Imprenza, Legacy, Outback and Tribeca. The 17841 and 17842 starters turn CW. Their applications include Toyota's Corrolla, Matrix, Echo and Yarus, Pontiac's Vibe and Scion's xA and xB. The two starters that you are most likely to see are those fitting the popular Camry and Corolla models. Those are the starters that we used for our photos.

All of these starters can be easily identified once disassembled by their armatures, which have a unique type of commutator (*see Figure 2*). As you can see in the photo, it is flat and the curved bars spiral out from the center. The starter's rotation determines the direction that the bars twist as they move away from the center. The bars on the commutator on the left in the photo slant in a CW direction. The right side commutator slants in a CCW direction. These armatures are very small when compared to most other automotive armatures (*see Figure 3*). Our photo shows one of the Denso armatures next to a Delco PG260M armature.

You can identify these starters prior to disassembly by the three brush holder screws on the commutator end (CE) frame and the black rubber plug that covers the CE bearing (*see Figure 4*). Two of the screws are side by side, serving to hold the brush holder in place while grounding the negative brushes. The opposite side screw secures a steel clip that holds the positive side of the brush holder.

The brushes are trapezoid-shaped. Along with the brush holder they slant in the direction of rotation to match the pitch of the armature's commutator bars (*see Figure 5*). Hence, the CW and CCW brush holders and brushes are different too. You must use the correct brush holder when assembling one of these starters. The easiest way to insure that is to simply hold the two parts together and observe that the brushes align with the bars (*see Figure 6*).

You may also notice that the positive and negative brushes are not positioned 90 degrees from one another as in most other starters. The positive brushes are located side by side with the motor lead coming out between them. The negative brushes are next to one another across from the positive brushes. While this arrangement in not totally unique, it is a departure from what we normally see.

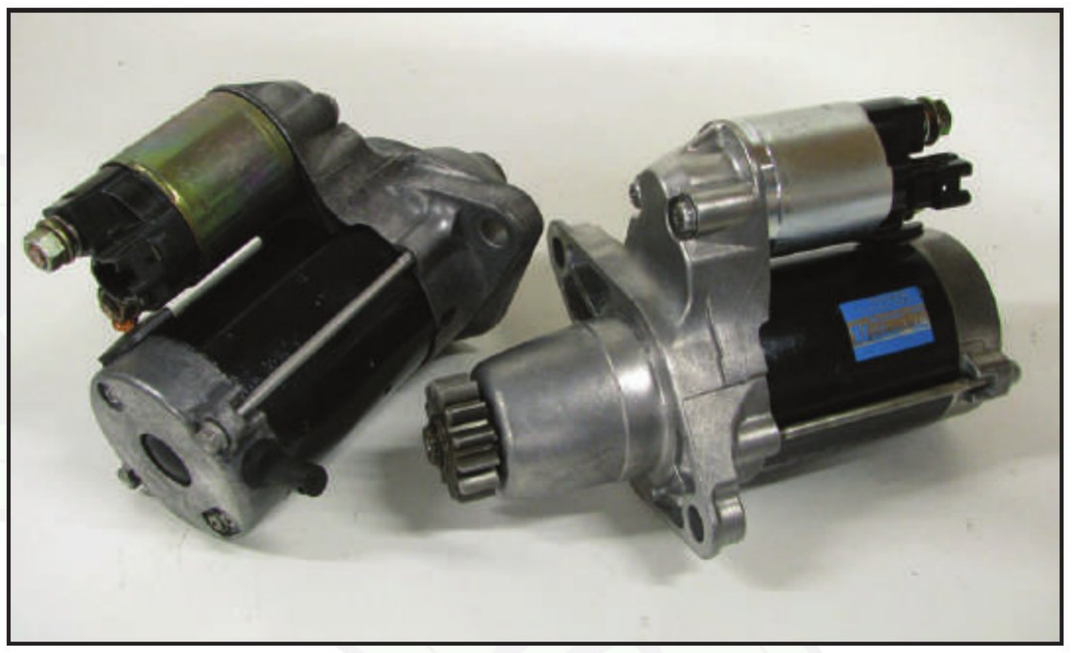

Figure 1 – Denso's Toyota Corolla (left) and Camry (right) starters are a departure from the OSGR Denso starters of previous years.



Figure 2 – Here you can see the CW (left) and CCW (right) armatures.

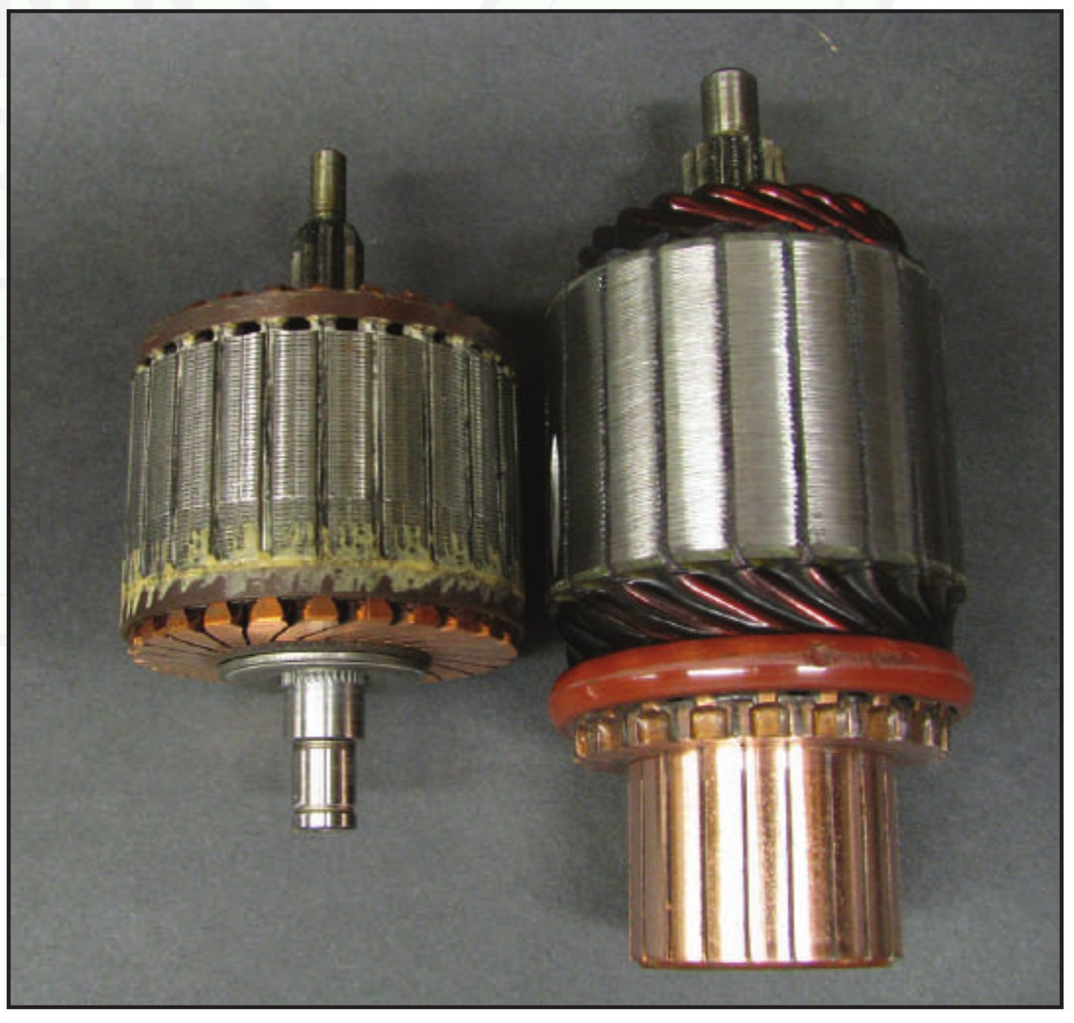

Figure 3 – You can see exactly how small the Denso armature is when next to a Delco PG260M armature.

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Figure 4 – You can identify a flat commutator starter by the three brush holder screws on the CE frame and the rubber bearing cover.

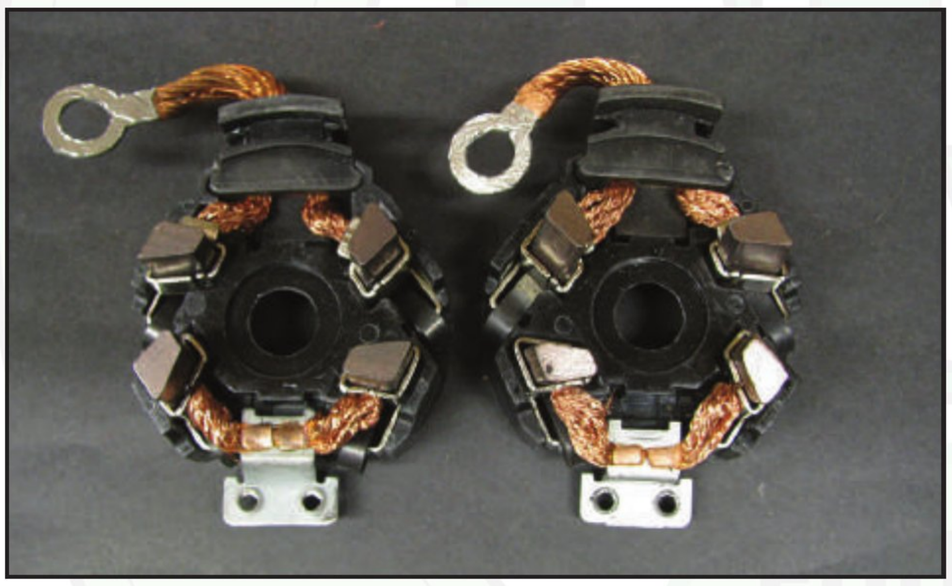

Figure 5 – The brushes are trapezoid-shaped and slanted to match the spiral commutator bars.

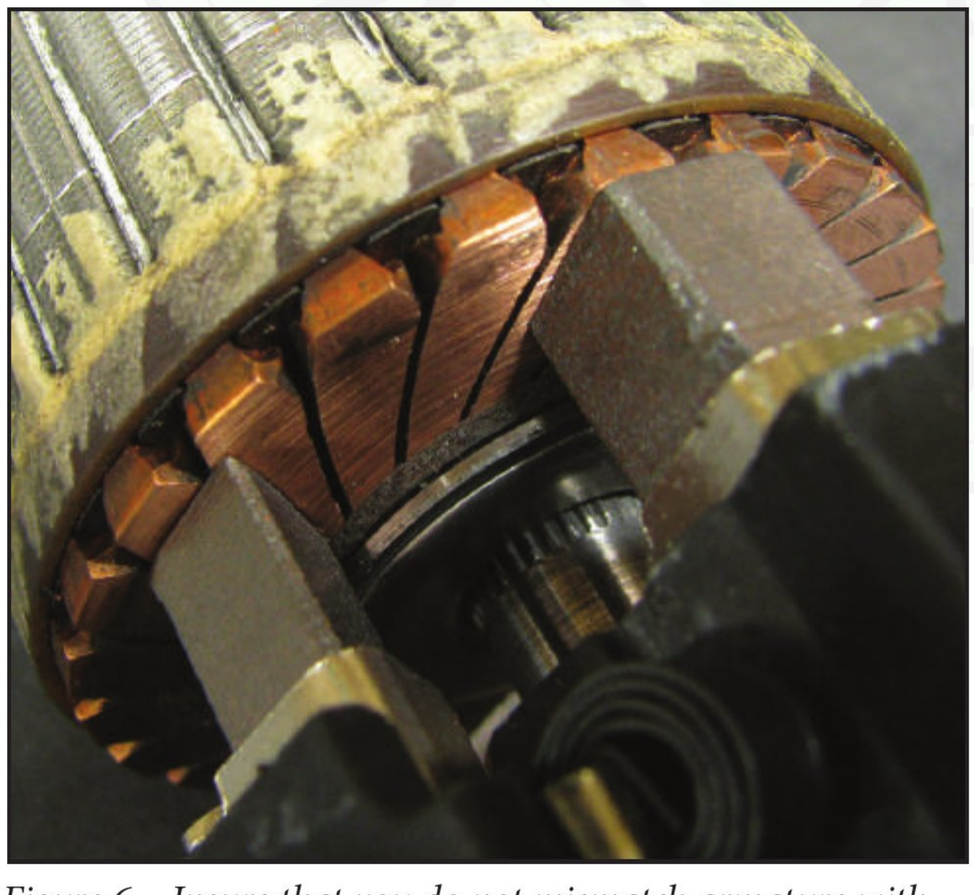

Figure 6 – Insure that you do not mismatch armature with brush holder. Make sure that the brushes align with the bars.



Figure 7 – This small snap ring and spacer washer are both tiny and important parts.



Figure 8 – Denso offers the snap ring as a service part. I highly recommend that you keep them on hand.

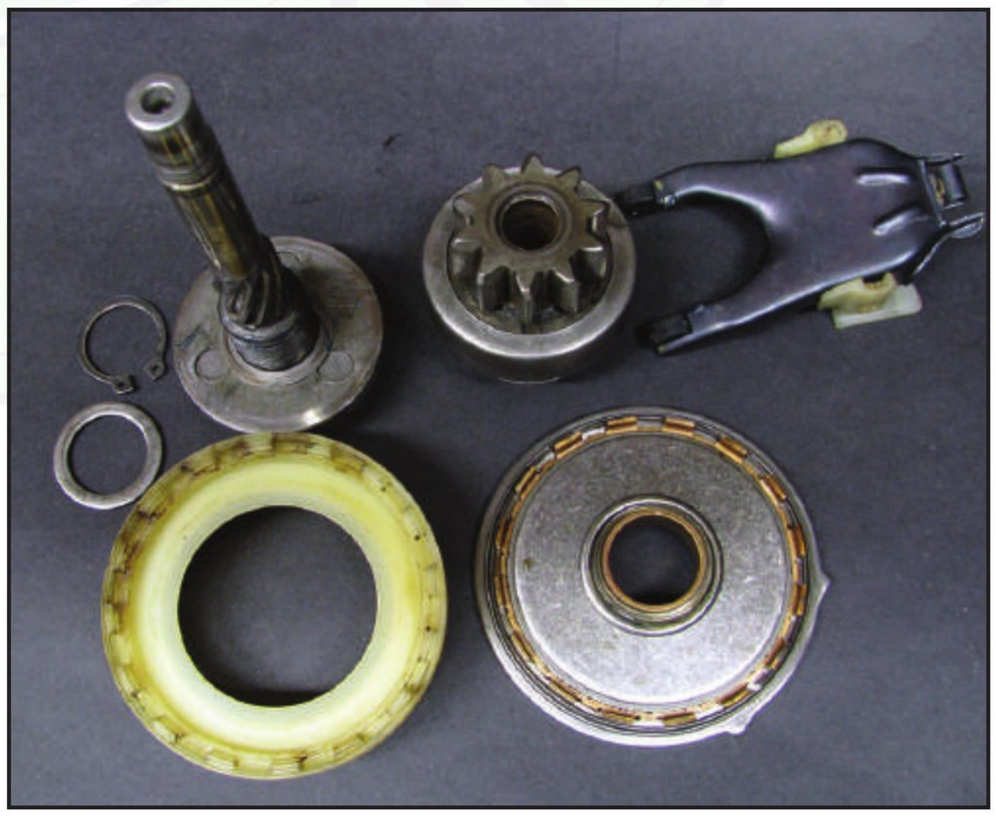

Figure 9 – The drive end components prior to assembly.

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During disassembly you will no doubt notice that a tiny snap ring holds the armature in place against a 608 bearing in the CE Frame. You will need to use your smallest pair of snap ring pliers to remove it. It is so tiny that it can be easily deformed during removal, dropped on the floor or become lost. This snap ring and the small washer behind it are critical parts (*see Figure 7*). The good news is that Denso offers the snap ring in a pack of 10 for less than a dollar (*see Figure 8*). When you order parts for one of these starters, do yourself a big favor and buy some.

When assembling one of these starters, there are some common mistakes that can cost you a lot of extra time. Once all parts are prepared and ready, follow this procedure for the quickest results:

1. Assemble the drive, drive shaft, stationary gear track, backing plate and planet gears (*see Figure 9*). Take care when fitting the plastic stationary gear to its backing plate.

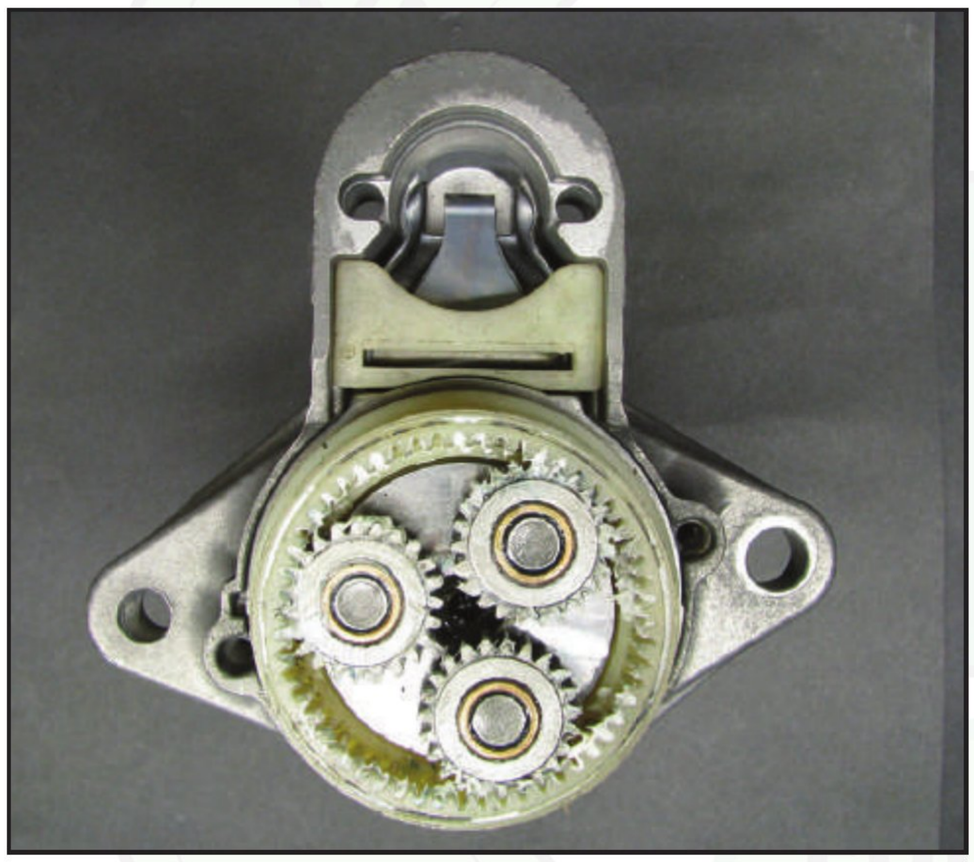

Figure 10 – The DE housing with components fully assembled.



Figure 11 – The 608 ball bearing must be fully seated in the CE frame to insure proper armature positioning.

2. Press the needle bearing into drive end (DE) housing. Then install the drive and gear assembly in the DE housing along with the shift lever (*see Figure 10*). Do not attach the solenoid just yet.

3. Press the 608 bearing into the CE frame, making sure that it is completely seated (*see Figure 11*).

4. Install the brush holder into the CE and tighten the three screws that secure it in place.

5. I found that using a C clamp is the best way to install the snap ring on the armature's shaft (*see Figure 12*). Push the CE frame assembly against the armature's commutator while rotating it slowly until the brush springs are compressed and then gently clamp them together. Tighten the clamp just enough for the plastic brush holder to touch the face of the commutator. This will allow you to use both hands when installing the washer and snap ring (*see Figure 13*).

6. Inspect the snap ring closely to insure it is tight and inside the groove all the way around the shaft (*see Figure 14*).

7. Make certain that the planetary gear cover plate is in the correct position inside the field case (*see Figure 15*) before mating it to the DE assembly. In doing so, insure that the locator on the field case is inside the indent on the DE housing (*see Figure 16*).

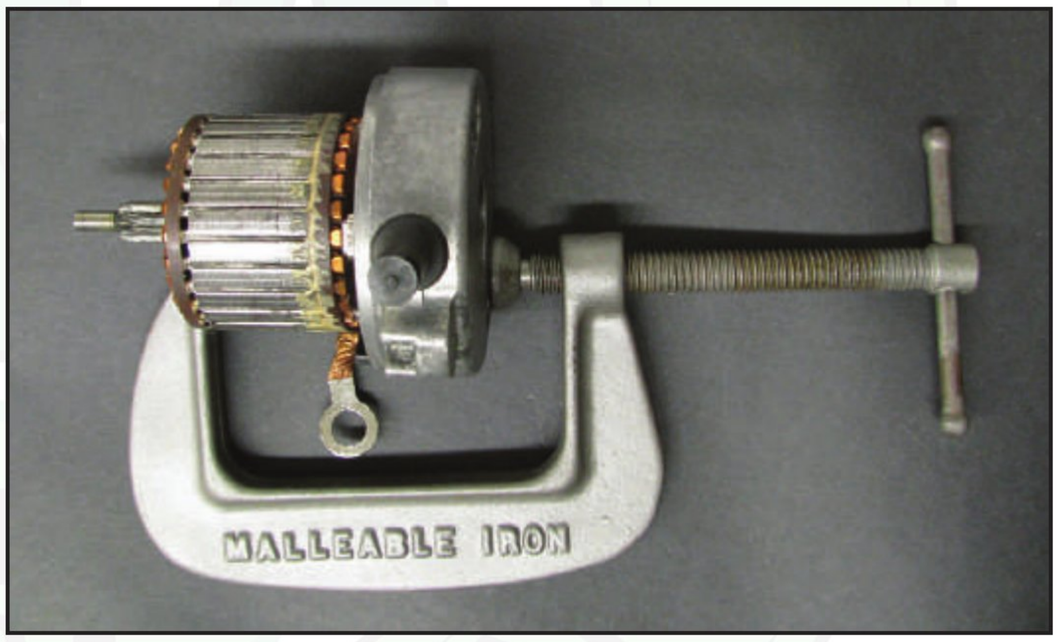

Figure 12 – A clamp like this one is the best tool to hold the armature in place while installing the snap ring.

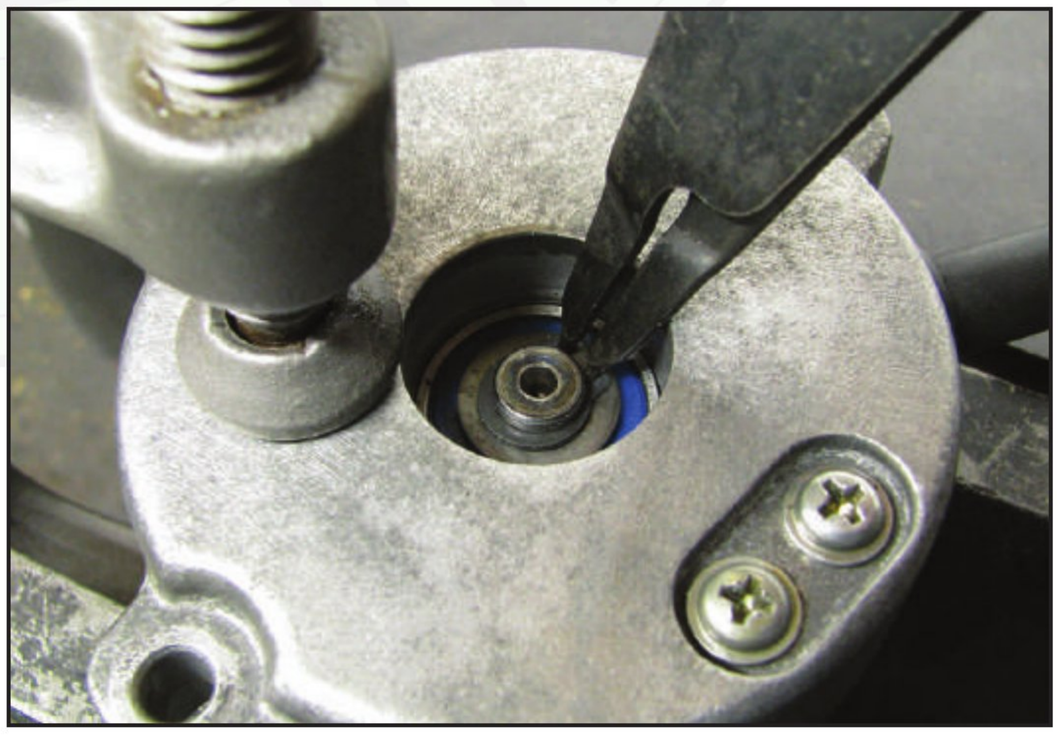

Figure 13 – The clamp allows two hands free to install the washer and snap ring.

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8. Carefully install the armature and CE assembly into the field case. Once the armature's shaft splines align with the planet gears, the magnets will pull in into place. Do not try to force it if it is not aligned.

9. Install the through bolts, shift lever cover, solenoid and CE bearing cover (*see Figure 17*). Test the starter and confirm that the direction of rotation is correct.

These starters were used as late as 2009 on some models. They were replaced on many applications by a similar looking PMGR starter (*see Figure 18*) that has a more conventional armature and commutator. The obvious differences are the number of brush hold screws on the CE frame, the lack of a cover for a CE bearing and the solenoid's attaching hardware – studs instead of machine screws. Some of the later starters will interchange with their predecessor on some applications, most notably on the Toyota Camry.

These are easy starters to rebuild and cores are readily available. Most of the vehicle models on which they were used have a reputation for longevity. Drives, solenoids and complete brush holds are available from multiple sources.

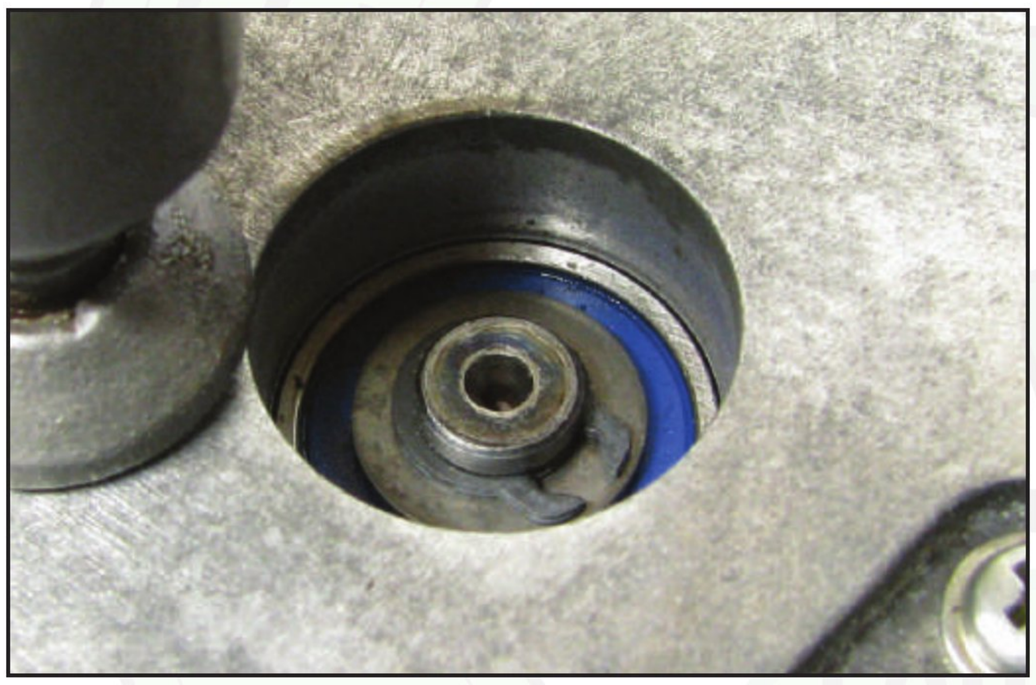

Figure 14 – Take a close look at the snap ring to make sure it is securely in place. A common error is over-stretching this ring which will result in a warranty return.

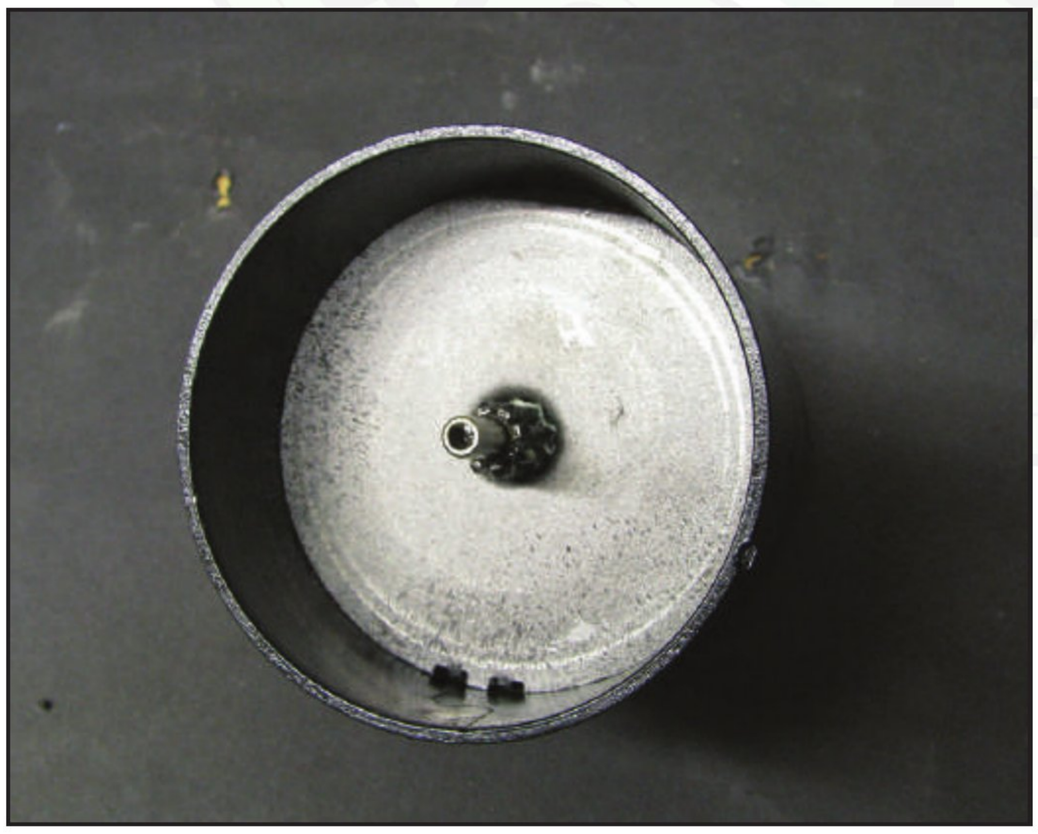

Figure 15 – The planet gear cover must be properly seated in place prior to mating the field case assembly to the DE assembly.



Figure 16 – Make sure that the locator bump on the field case is aligned and seated into the DE housing's indent.

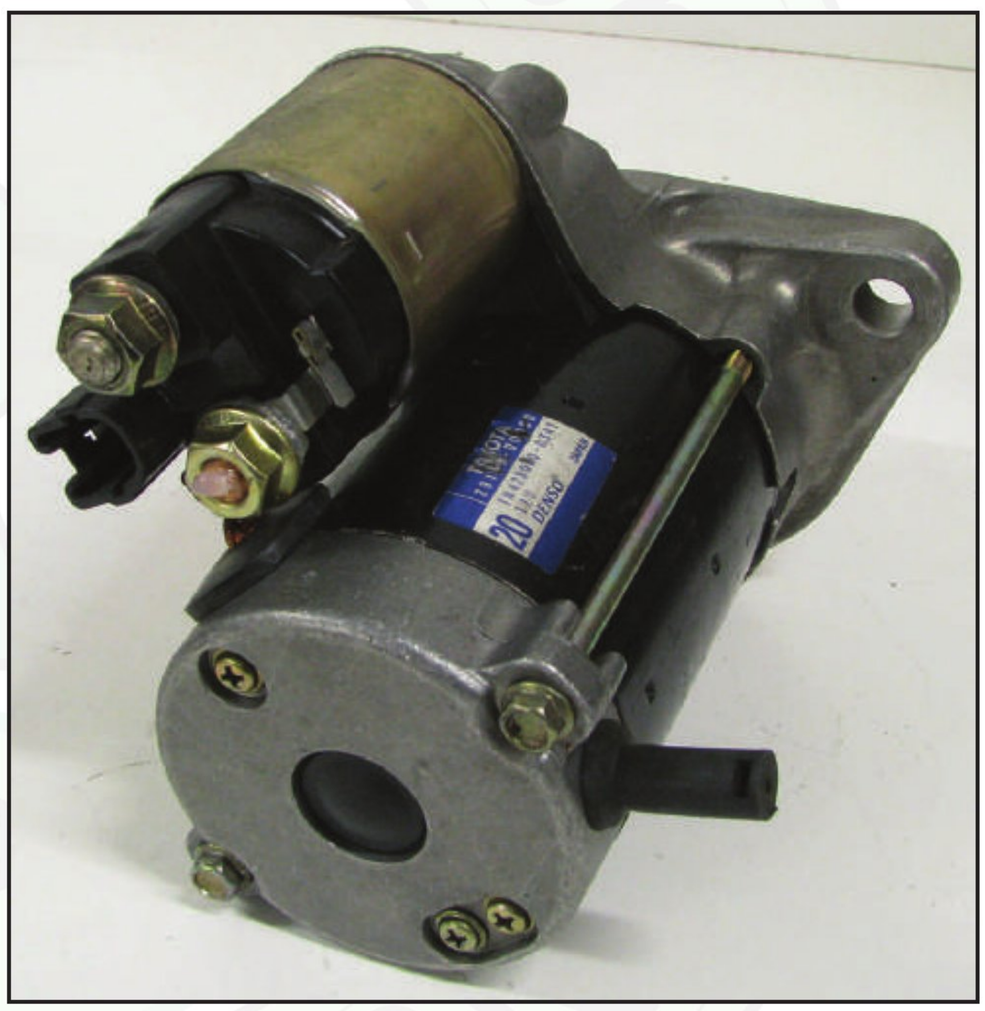

Figure 17 – When testing, double check rotation to insure that parts have not been mismatched.

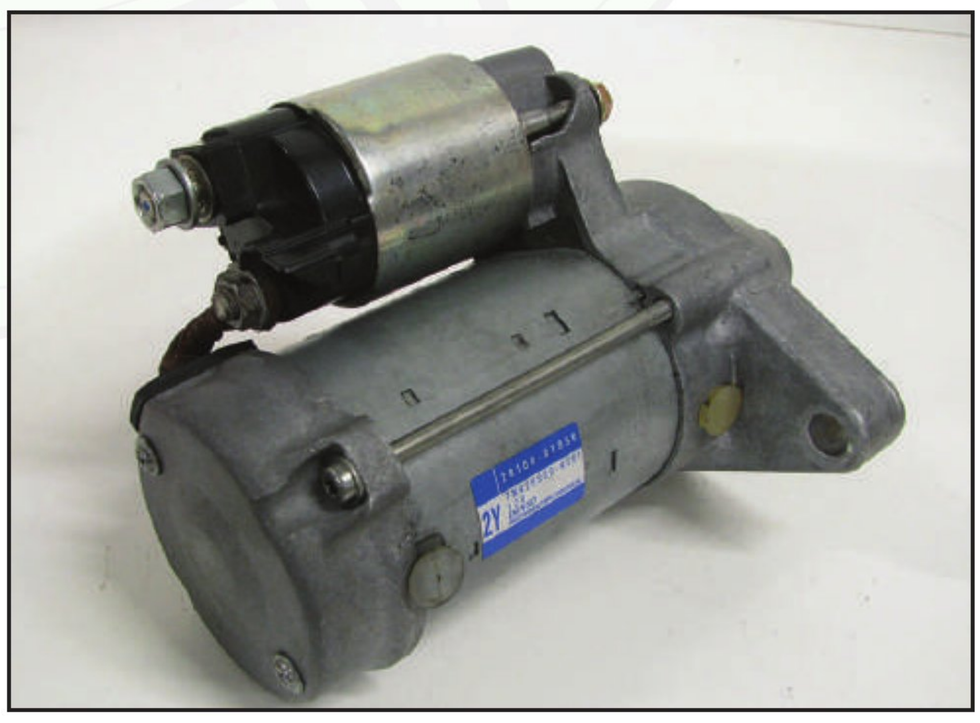

Figure 18 – Denso replaced the flat commutator starters with a newer version using a more conventional armature.

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