

Beech on a Budget

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By Mike Caban

Continental Starter Adapter Mysteries Revealed

The right-angled starter adapter on Continental engines (**Figure 1**) has been in use going back to the days of the O-300 and IO-346 engines, and up through the E-Series and into the 470, 520, and 550 engines of today. While Lycoming chose a lower maintenance ring gear and starter arrangement that keeps gears and their metal machinations out of the engine, Continental chose to incorporate the gearing within the confines of the engine. This design utilizes a steel worm gear (**Figure 2**) that is driven by the starter, which engages a brass gear and torque spring (**Figure 3**). When the brass gear spins the spring, it causes a tightening action around the end of a geared shaft (**Item #37 in Figure 1**). It is the geared shaft connected to an internal engine gear within the engine case that cranks the engine over. This spring and engine drive gear shaft interface is the clutch mechanism that allows the engine to spin up after starting without driving the starter motor back through the gearing. Driving the starter motor would turn it into a generator, which would not be a good thing.

In my opinion these two pieces, the spring and the shaft it grabs, are the crux of the tough business going on in this mechanism. After gripping the drive shaft tightly for starting, it is crucial that the shaft unwind at least one full revolution after engine start to allow the spring to release its driving grip. Since the shaft is connected ultimately to the starter motor drive armature at the engagement slot (**Figure 2**), the spring must be able to overcome the drag of the starter motor armature. This amount of force has been described in Aircraft Specialties Service Bulletin S-2008-01 as less than five inch-pounds. Essentially, a starter motor shaft can be turned by your thumb and index finger.

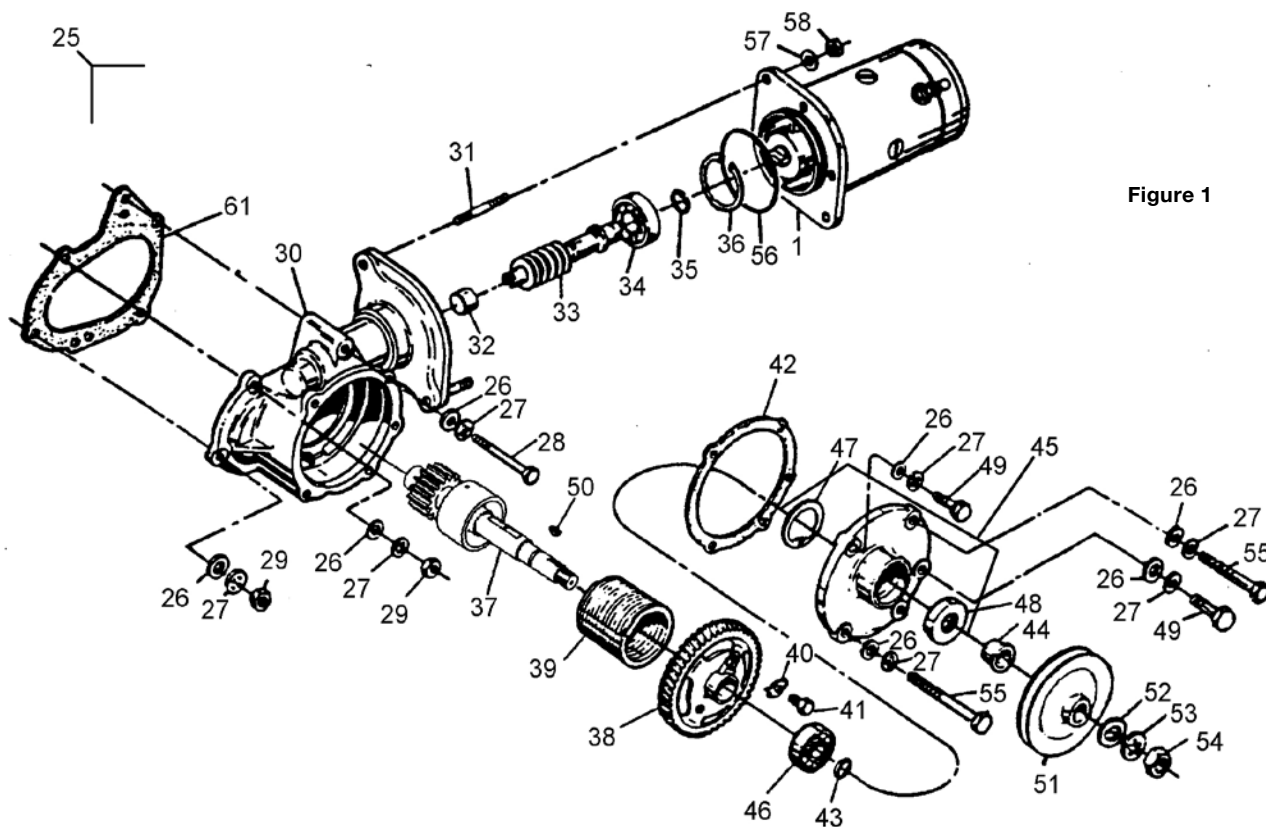
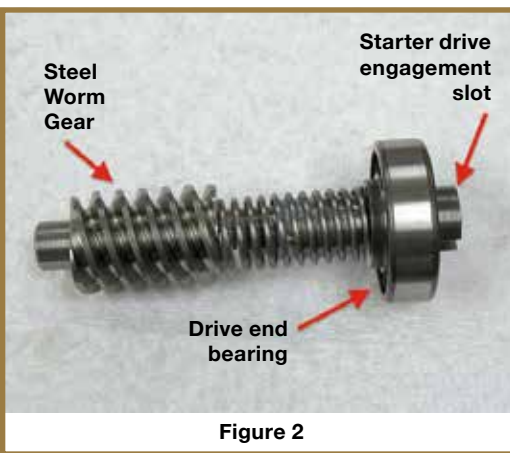


Figure 1

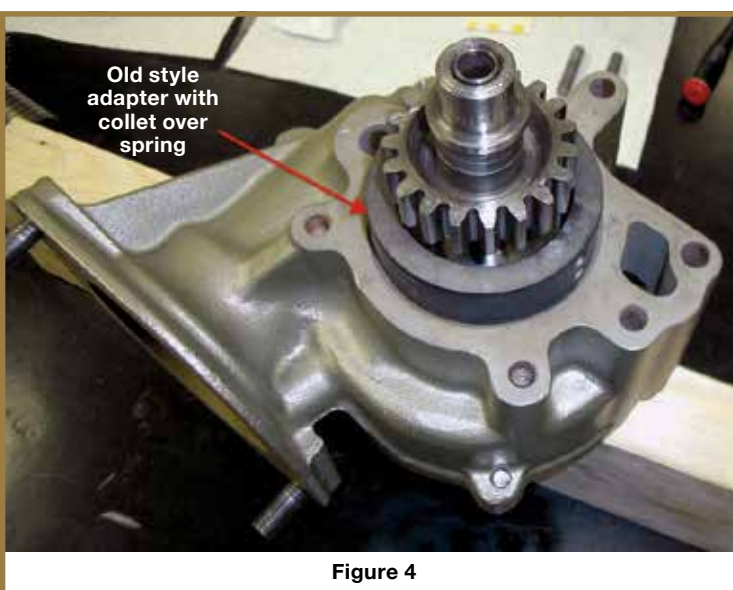
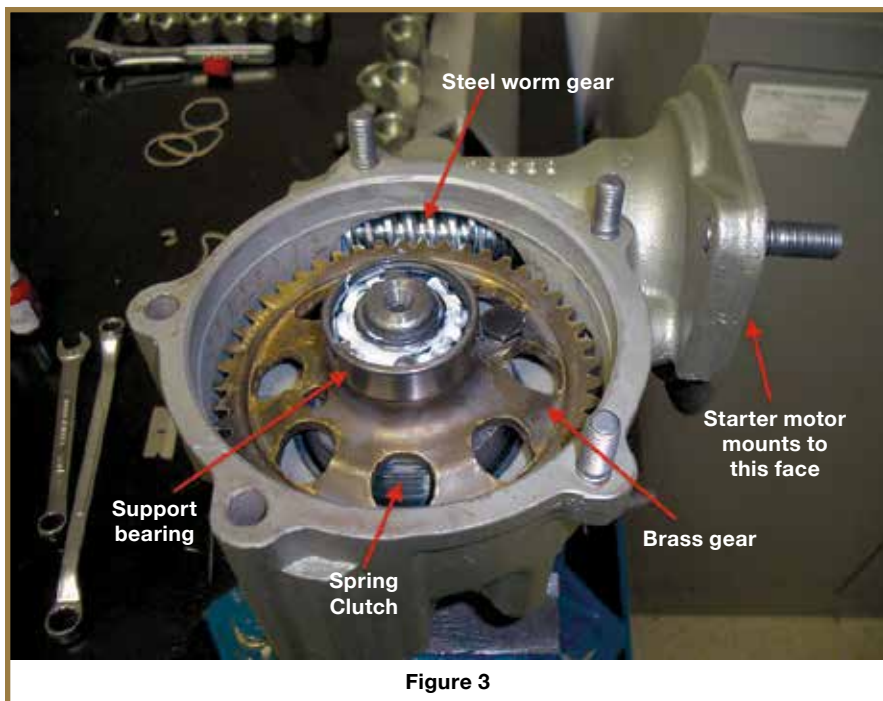


If the spring is not fully released from the shaft, there will be an interference contact between spring and shaft – and presto, wear will begin to occur at this spring/shaft interface. At some point there will not be enough gripping force when the starter is engaged and a slipping or slower than normal turning propeller will be observed. In its worst form, this wear will result in catastrophic failure and possible metal contamination of the engine.

Old and New

There are currently two types of starter adapters built by Continental: old style and new style. The old style has a snug-fitting, sleeved collet over the spring (**Figure 4**). It is critical that the spring be allowed to turn backwards and relax in this adapter design. The new style design does not employ a constraining collet on the engine drive gear side of the spring. The drive shaft of the new style adapter shaft is designed to permit a slight rubbing tolerance to the spring.

As permanent magnet gear reduction starters came on the scene, the Iskra from Continental in 2002 and also the Sky-Tec plus the Hartzell's M-Drive, people learned very quickly that one inherent characteristic of these starter motor types (as opposed to the old Delco, Energizer, or Prestolite field wound starters of yesteryear) is that they do not turn backwards very easily. Many owners experienced some unintended consequences, to say the least, when employing these new-style starters with their old-style adapters. **Figure 5** shows the remnants of a broken adapter spring and the engine bearings found during an engine tear-down, resulting from starter adapter metal contamination in the engine.



The Hartzell M-Drive (www.hartzell.aero) debuted around 2010 and features an in-line solenoid that electro-mechanically connects and disconnects the starter motor to the adapter drive shaft. This essentially reduces the reverse torque value to near zero. Hartzell does not recommend installation of their M-Drive starter if:

- A lightweight starter made by any other company other than Hartzell has been installed previously, even if done by the engine manufacturer, or
- The starter adapter has not been verified as good by disassembly or overhaul.

Hartzell also offers the old-school field wound starters in its Energizer and Prestolite brands. The Energizer is offered in new and overhauled condition, and the Prestolite is only available in overhauled condition.



Figure 6

Sky-Tec's (www.skytecair.com) lightweight line debuted in the early 2000s with its ST-3 starter. Weighing in at about 6.5 pounds, the line has since evolved to add the ST-4 and ST-5, with the -5 weighing in at about 9.4 pounds. Sky-Tec says its ST-3 is the current original equipment starter for IO-520 and IO-550 engines on 24-volt electrical system airplanes owing to its extreme light weight. The -5 sports a piggybacked solenoid affair for a more positive disengagement of the starter from the adapter shaft (Figure 6).

The old-school heavyweight Delco, Teledyne, and Prestolite starters use a conventional rotating armature and fixed field winding. The armature is a set of coils wound around a central shaft. The field is constructed of a tightly wound set of coils that are fitted inside the starter motor case. The armature is connected to the field through a pair of spring loaded brushes, whose faces ride on a section of the armature called the commutator. Aircraft battery voltage is applied via the starting switch, which closes the starter relay contacts, which then carry the big in-rush of current from the battery to the brushes and onward into the armature. This current flow in the presence of the field windings produces torque causing the armature shaft to rotate rather enthusiastically, thus turning the input shaft and worm gear of the starter adapter.



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Assuming that you are not chasing the weight reduction benefit of the lightweight permanent magnet starters, another source for a low-cost starter selection would be an independent starter and alternator overhaul shop such as Modified Aircraft Accessories of Brooks, Kentucky. Modified (www.modifiedaircraftaccessories.com) is owned and operated by Jimmy Schreiner and his wife Debbie. They have been in operation for 29 years and for the last 20 have provided me with all my starter and alternator repairs and overhauls to a two-thumbs-up standard of excellence. With your large old-school field wound starter core, they offer direct-to-owner overhaul pricing of \$220 for the old-school Delco starters. With the exception of a short period of time where I tried a pair of ST-3 starters in 2006, I've been running Modified's Delco starter overhauls on both of my Baron's IO-470s and my starter adapters

are in the neighborhood of 1,700 and 2,100 hours time-in-service without any issues.

The selection of a starter style can play a big role in the life of your starter adapter and the two most critical components within: the spring and the drive shaft that perform a driving and clutching release action within the mechanism. Choose wisely in this area, my friends!

Sources for repair and overhaul of complete starter adapters include Niagara Air Parts (www.niagaraairparts.com) and Aircraft Specialties Service (<http://www.aircraftspecialties.com>). Be careful of operations where pricing includes a core charge/exchange that is expected to be refunded upon return of your core. Your core might be deemed un-repairable, therefore forfeiting a rather high core charge. Niagara also offers a starter adapter



Figure 7

overhaul kit (**Figure 7**) that includes bearings, gaskets, snap rings, seals, and bearing grease for a field overhaul.

A few of the components may also be able to be sourced from National Bearing Supply distributors at prices lower than aviation supply sources. Of course, this option is available only if your mechanic is open to the equivalent substitution and will (by entering it in your engine logbook) authorize their use in aircraft under the following part numbers:

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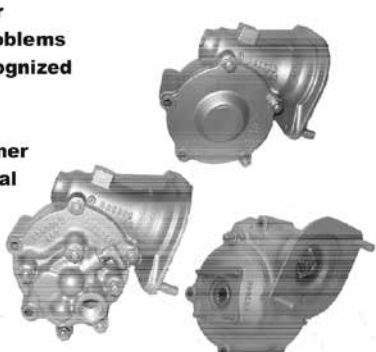
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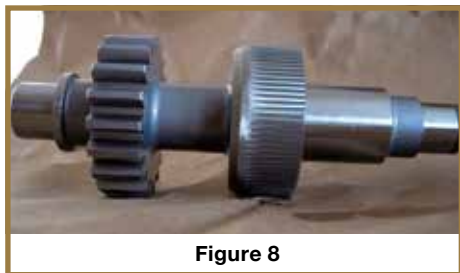


Figure 8

- Rear seal: National 450588
- Starter shaft bearing: Timken 204PP
- Inner shaft bearing: Timken 203K

Field Repairs

Combining a rebuild kit with a matched machining of your adapter drive shaft, fitted to a new dimensionally correct undersize ID spring from a repair shop certified to do this work, could be a low-cost way to go for bringing a slipping or damaged adapter back to service. A few years back, Baron owner Paul Mandel reported to me that he had an event with a slipping starter adapter. Here is his pipe on



Figure 9

Aircraft Specialties Service, which he provided me permission to quote.

"We disassembled my slipping adapter and measured the wear according to the manual, found the shaft and spring to be worn beyond limits. I sent the parts to Aircraft Specialties and they ground the shaft and drive gear, then supplied the new M15 undersized spring for about \$300. My A&P and I re-assembled and tested the unit thoroughly and replaced it, and it has worked perfectly for about 250 hours now.



Figure 10

"The biggest change was going to the old Prestolite starter [from his previous Iskra] which performs wonderfully. The spring needs high torque to operate without slipping and the older TCM/Prestolites can do that."

Paul's pictures of the components he received from Aircraft Specialties are seen in **Figures 8, 9 and 10**.

So there you have it: The critical business pieces of the adapter returned to service for a reasonable cost, plus labor and miscellaneous bearings, seals, gaskets, etc. 

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