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Service Letter

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TECHNICAL DISCUSSION REGARDING STARTER ADAPTERS & M-DRIVE STARTERS

INTRODUCTION:

The "TCM Starting System" consisting of both a starter motor and a starter adapter coupled to the Continental engine has been around for many years. Recent market demands have stressed higher performance, lighter weight, longer design life, and lower current draw from the starter. Today's technology allows these improvements in the starter motor but that is only half of the starting system. Powerful high strength permanent magnet, gear reduction motors have been designed to satisfy the market demand, but one inherent characteristic of all gear reduction motors is that they DO NOT turn backwards easily.

In the TCM starter system, a key operating characteristic is that once the engine starts, it is necessary for the starter motor drive shaft to turn backwards to relax the starter adapter's wrap spring compression in order to disengage the starter motor from the starter adapter. If the motor resists reverse movement, the wrap spring tension is maintained on the starter adapter drive shaft after the engine starts causing excessive wear of the spring and drive shaft during normal engine operation. This will eventually result in slippage or catastrophic damage requiring removal and overhaul of the starter adapter.

Hartzell Engine Technologies (HET), the new owner of a company that has been an OE starter motor supplier for over 25 years, designed the M-Drive lightweight starter to avoid these conditions while achieving superior performance. Reducing the M-Drive's reverse torque to near zero was accomplished by designing an in-line solenoid that electro-mechanically connects the starter motor to the starter adapter drive shaft. Consequently, when the ignition key is released at engine start, the solenoid completely disengages, allowing the M-Drive's output drive shaft to turn backward relaxing the wrap spring and allowing the starter adapter drive shaft to rotate freely without excessive wear or damage. A complete technical discussion has been created below to educate anyone who installs or purchases a new HET M-Drive starter.

This service letter provides a technical discussion for purchasers or installers of the Hartzell Engine Technologies lightweight M-Drive starter.

NOTE: HET does not advise the installation of a new M-Drive starter if:

- (1) A light weight starter made by any company other than HET has been installed, even if done so by the engine OEM, or
- (2) The starter adapter has not been verified as good by disassembly or overhaul.

DISCUSSION:

The purpose for this discussion is to educate those who plan to purchase or have purchased and will be installing an M-Drive starter on an existing starter adapter. After the release of the M-Drive, HET received early customer feedback indicating that the starters were causing starter adapter failure in just a few hours. Our subsequent investigation uncovered what is essentially an old problem but one which has been exacerbated with the advent of new generation starters which do not allow the starter adapter's wrap spring to relax.

Questions? Contact Customer Service at (877) 359-5355 or (334) 386-5400

DISCUSSION: (cont'd)

In our technical discussion, we will first start with the TELEDYNE CONTINENTAL MOTORS starter adapter. The starter adapter is essentially a TCM design, though there are PMA units available, so we will refer to them only as starter adapters. The basic design type for the 360/470/520/550 as well as the GTISO-520 series, uses a two-inch spring on a clutch drum. Starter adapters are installed on both sandcast and permold cases with the original "old style" having a sleeved collet over the clutch spring and the "new style" having an open spring without the sleeve. The principal concern pertains to those applications with a sleeved collet whether used on sandcast or permold case, especially if a new light weight starter, like the "Iskra" has been installed.

It is important to understand how each starter adapter design works. There are two designs which we will refer to as "old style" and "new style"

Old Style: (WITH sleeved collet) See Fig. 3

The starter motor turns an internal worm gear in the starter adapter via a slotted coupling. This gear then turns an internal brass gear that is connected to one end of a tightly coiled spring. (See Fig. 1 & 2.) The O.D. of the other end of this spring fits snugly into a round sleeved collet. The starter drive shaft and clutch drum, with the integral engine drive gear, fits inside this spring and is geared directly to the engine crankshaft. The drum just inside the spring is nearly two inches in diameter so that it clears the spring. When turning the key to start the engine, the spring winds up tight around the clutch drum on the main gear starter drive shaft and turns the engine over. As the engine gains speed, the drive shaft speed exceeds the spring speed, tending to unwind it. However, the spring will retain a tight grip on the clutch drum until the starter motor stops turning. If the starter motor drive shaft is able to turn in the reverse direction, the spring will relax. IT IS CRITICAL THAT THE SPRING BE ALLOWED TO RELAX. If the spring does not relax, the grip used to facilitate start will now "grind" the clutch drum down as unintended contact between the spring and clutch drum is now present during normal engine speeds.

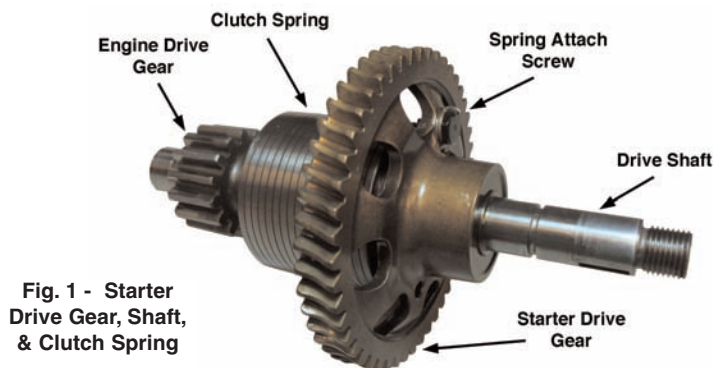


Fig. 1 - Starter Drive Gear, Shaft, & Clutch Spring

Fig. 2 - Starter Coupling & Worm Gear

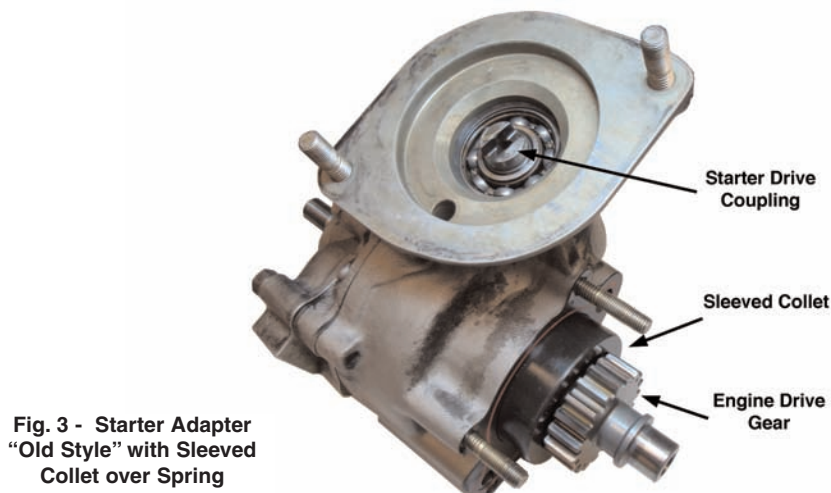


Fig. 3 - Starter Adapter "Old Style" with Sleeved Collet over Spring

DISCUSSION: (cont'd)

New Style: (WITHOUT sleeved collet)

The starter motor turns an internal worm gear in the starter adapter via a slotted coupling. This then turns an internal brass gear that is connected to one end of a tightly coiled spring. (See Fig. 1 & 2.) The I.D. of the other end of this spring fits very snugly onto a round clutch drum on (See Fig. 1) the starter drive shaft, which is geared directly to the engine crankshaft. The clutch drum is nearly two inches in diameter so that it just touches the spring maintaining a slight “rubbing” tolerance. When turning the key to start the engine, the I.D. of the spring winds up tight around the clutch drum on the main gear starter drive shaft and turns the engine over. As the engine starts and gains speed, the drive shaft goes faster than the spring and tends to decompress or “unwind” it. At this point the spring releases the drive shaft and the starter motor stops turning. In the “new style”, the end of the spring opposite the starter drive gear is not constrained in any manner which is in contrast to the “old style” with the sleeved collet covering that end of the spring.

Before Installing an M-Drive:

The worse case but most typical condition, is one in which the aircraft starter motor, (for any reason), will not reverse direction to allow the clutch spring to relax. When this occurs the spring will remain tightly wound on the clutch drum as the engine operates at normal speeds. As the starter clutch drum now is rotating within the compressed spring, the spring will begin to wear away the clutch drum diameter. This is especially true for the “old style” starter adapter as it is designed to operate without spring contact during engine operation. Since the majority of the existing TCM engine fleet still use the “old style” starter adapter, these adapters will require a close examination before installing an M-Drive starter.

When the M-Drive starter is installed on any “in service” starter adapter, whether “old” or “new” style, the new M-Drive starter will, in a short period of time, reveal that the starter adapter is damaged or worn out very quickly. To avoid installing a new M-Drive on a worn-out starter adapter, look for the following conditions:

An oil sample or filter examination that shows ferrous particles (can be isolated by means of a magnet). The starter adapter spring has ground down the drum and is scoring the steel flange creating cut shavings or smaller particles from an unreleased spring wearing the clutch drum and spring.

Worn out starter that is weak or where the starter motor internal friction keeps the starter adapter spring engaged after starting. This condition occurs in “old style” starter adapter that utilizes the original sleeved collet. Also the starter drive blade must never bottom out in the coupling slot. *Remember, an unpowered starter drive shaft Max resistance to rotation in either direction is a critical value! It should be less than 5 in-lbs in either direction.*

A previous replacement starter motor that had internal friction with the gear reduction preventing the starter adapter spring from fully disengaging after start. The starter motor should turn freely using only your fingers (not greater than 5 in-lbs). Many geared starter motors (new light-weight) do not allow the starter adapter spring to properly relax causing short starter adapter life or damage.

Starter adapter oil passages clogged due to infrequent oil changes and sludge build-up causing abnormal spring engagement or disengagement conditions.

TCM engines with intermittent or continuous slipping starter clutch in starter adapter.

Starter adapter with no clear history of overhaul or repair. Starter adapters are required to be overhauled at engine TBO, make sure there is a record before installing the starter.

To conclude this discussion, it is advised that if you plan to use an M-Drive starter to replace any new “light weight” starter now installed (other than HET), you must be very careful in your inspection of the starter drive, especially if you have the “old style” adapters with a sleeved collet. If you remove the old starter, the spring will naturally relax to its original state but wear to the clutch drum has already occurred. Thus, the adapter will begin to slip with the new M-Drive in a short time or immediately depending on condition. Even if you re-install the old starter, the problem will remain due to the wear and damage previously done, *a properly installed M-Drive starter will not damage a healthy starter adapter.*

DISCUSSION: (cont'd)

There are a few checks at the engine you can make prior to the M-Drive installation. First, listen closely as you remove the old starter. You should not hear the clutch spring unwrapping, as normal installations allow the starter to back off relaxing the spring after each start. If you hear this noise, it will be a good indication of trouble ahead. Next, with the old starter removed, for the "old style", turn the starter adapter coupling in the *direction of start* a turn or so. (There should be an engraved arrow showing the direction the starter motor turns.) Resistance will come as clutch spring engages trying to turn the engine over. If it keeps on turning without resistance or prop movement, it is a sign that the spring has broken or has worn so much it slips. For the "old style", turn the starter adapter coupling in the *opposite direction* of start and after a turn or so, the collet will capture the spring and try to unwind it causing resistance and a spring back when you release the coupling. Again if this does not happen and it turns more or keeps turning, it is a sign that the spring has broken or the shaft has been severely damaged. If the coupling is turned freely in both directions, the starter adapter is damaged and should be removed for overhaul or replacement. It should be noted that for the "new style", (those without the sleeved collet), the check is the same except, when turning the starter adapter coupling in the *opposite direction* of start, it will turn freely with only moderate resistance.

In our certification testing the M-Drive starter, many thousands of starts were made checking for endurance, reliability, and longevity. The vast majority of these starts were done on a TCM six cylinder engine utilizing an overhauled "old style" starter adapter with a sleeved collet. An accumulation of over 6,000 starts using various starters have been made on this adapter without incident. In addition, tests have been performed on various other "new style" starter adapters to help identify the problem areas described in this discussion. With due diligence in the examination of your starter adapter, the M-Drive starter will provide easy, economical, and reliable service that should last to engine TBO.

WARRANTY STATEMENT:

No warranty is applicable to this Service Letter. Issuance of this service letter in no way constitutes an implied or expressed warranty of any kind.

This publication does not imply or state any responsibility for the advice to or workmanship of any person or entity performing work or maintenance on the engine starting system.

CONTACT INFORMATION:

If you have any questions concerning this service letter, please contact Hartzell Engine Technologies Technical Support at 888-461-6077. E-mail communication may be obtained by going to our website: <http://www.HartzellEngineTechnologies.com> and selecting "Contact" at the top of the page. You may also write:

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