

LeuCat

Repairing And Servicing The Yanmar SD 40 & 50 Drive Cone



Provided by Dave Leu of S/V Leu Cat

With Lots Of Help By Mark Scapens of S/V Isabella

And Updated by Craig Muma of S/V Sail On

Preface and Acknowledgements

While sailing around the western side of Fiji, Mary Margaret and I dropped the hook in a nice bay on the northern side of the Island of Waya. We had noticed that we were sharing the lovely anchorage with another Lagoon 440, S/V Isabella. We just had to run over and introduce ourselves and meet some other Lagoon lovers. We met Mark Scapens and his wife, Shaz, from New Zealand and had a great time sharing sailing stories which, of course, included a few repair yarns. One of the repair experiences we shared was the lost power in one of the Yanmar saildrives. For both of us, the problem turned out to be a worn drive cone. This puppy is like a clutch in a car. When it goes, you just cannot put the engine into gear. I ended up paying about \$1200 to have it replaced. Ouch! However, Mark shared with me how he fixed the drive cone himself and saved about \$1100. I pleaded with him to share with me what he did and he was kind enough to give me a blow by blow description. I wrote down his instructions and added figures from the Yanmar saildrive maintenance manual so that others may benefit from his experience. Together, the instructions and the figures should be enough for you to make this simple repair yourself. It usually costs upwards to \$1200 to \$1700 to have a mechanic replace the drive cone and it usually takes at least a day for him to do it. This will cost you virtually nothing (*under \$100 anyway...if you don't count the tools you may want to buy*) and should only take a few hours of your time.

I also wish to thank Craig Muma of S/V Sail On. He was kind enough to use this procedure and then added some excellent additions and insights that he gathered from the "School of Hard Knocks" that make this job easier. I have highlighted his notes in **red**.

One symptom that you may notice which indicates that your drive cone is slipping is that you cannot get your saildrive into gear. No matter what you do with your gear shift up at the helm, the saildrive does not engage and the propeller does not turn. When this occurs, first make sure your linkage to the shift lever on the saildrive is working and moving the shift lever when someone moves the helm's gear shift into forward then neutral and then reverse and back again. If the shift lever is moving at the saildrive, then the problem will be that your drive cone is slipping and needs to be repaired. To repair it, you will remove the cone drive and rub some grinding paste around the sides of the drive cone and inside the cave of the clutch gear and "lapping" it five times. This roughens the surfaces and restores your drive cone.

On "Sail On" our symptom was just slipping. We could get it into gear just fine, we just couldn't get any drive out of it. We turned off the engines and put the shift in reverse so I could dive the props. I found that the Port prop would free-spin in one direction (as it is supposed to) and only provide minimal drag when hand turned the other direction. A quick check on the Starboard prop verified that I could not turn it at all in one direction (as it is supposed to be). At the end of this revised protocol you will find out that we were unsuccessful in solving our problem...because it WASN'T the cone drive, our symptom was not indicative even though several people, including me were SURE it was. Perhaps Dave's symptom is the only one that one should connect to this protocol.

Word of warning: I have not done this procedure myself. Mark has and says that it works great. I have taken copious notes from his verbal instructions and I believe I have gotten everything down correctly. Based on

what Craig learned in following, I believe I did a pretty good job. However, please pay especially close attention to Craig comments as they are based on his experience and I believe his words of wisdom are very insightful.

Trying these instructions costs you nothing but your own time and if you are not successful, then you can always resort to the traditional method of hiring a mechanic.

Remember: GO SLOW! Devise a system so you can reassemble the bits in the exact order, right side up.



You should also note that this document is just one of four Techno-tip documents that my wife and I are the process of completing. The other three include a compendium of over 650 techno tips we wrote while cruising around the world; one on travel tips that my wife and I have written, one on Galley tips that my wife has written. Please let us know if you are using any of these documents and if you have any improvements or additions. We would greatly appreciate hearing from you. You can reach us at: davidjleu@gmail.com

Best Regards and great sailing...

Dave Leu

S/V Leu Cat
Rebak Island, Malaysia 2013

Alright, with that background and introduction, let's get roll up our sleeves and get started...

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Step 1: Remove The Upper Cover Cap and Drain Some Oil

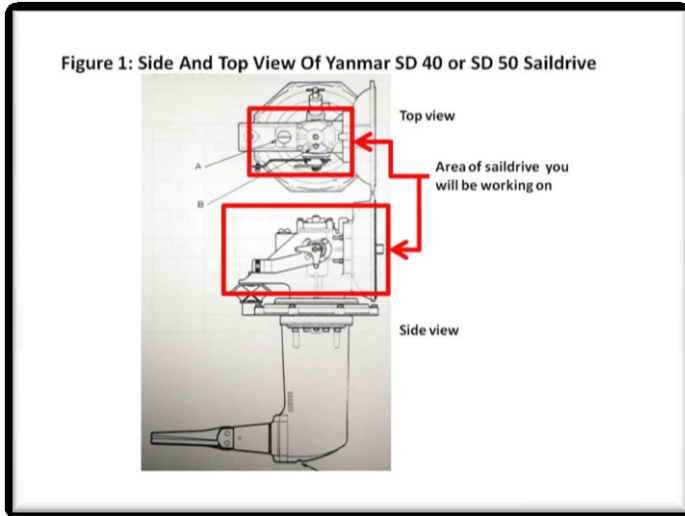
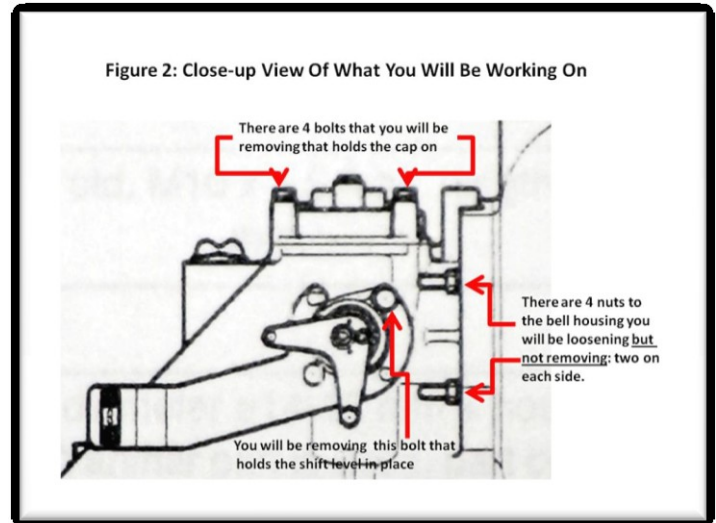


Figure 1 shows the side and top view of the saildrive and highlights the area of the saildrive you will be working on.

Figure 2 is a close up of the area of the saildrive you will be working on. It also shows the bolts and nuts that you will be removing or loosening. The secret of not having to separate the engine from the saildrive and then moving the engine forward is that you will just be loosening the 4 nuts at the bell housing but not removing them from the stud bolt. You then push those stud bolts forward and it backs the pinion gear and its shaft away from the drive cone



assembly and allows you to remove the drive cone assembly. You will also be removing the shift lever assembly before you remove the drive cone assembly.

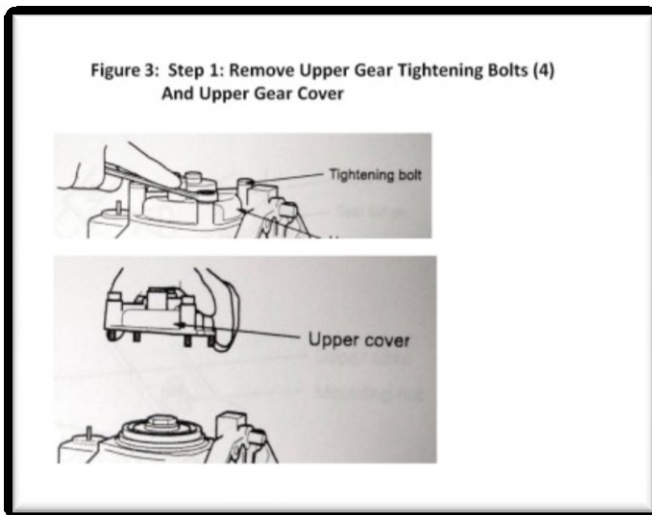
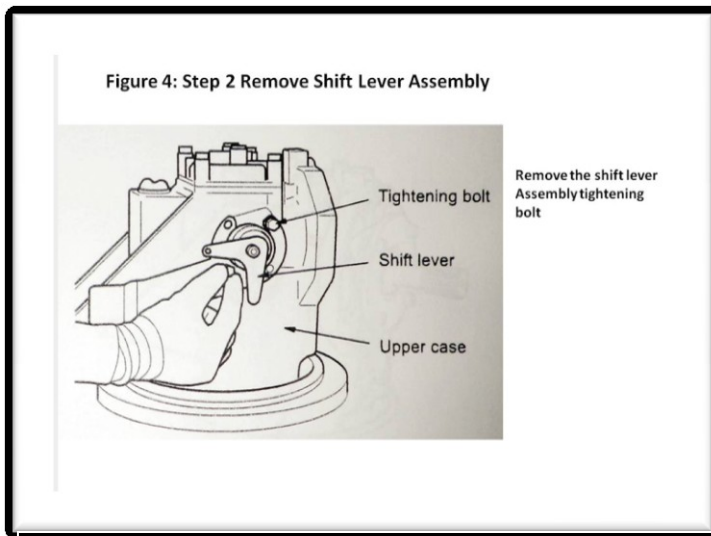


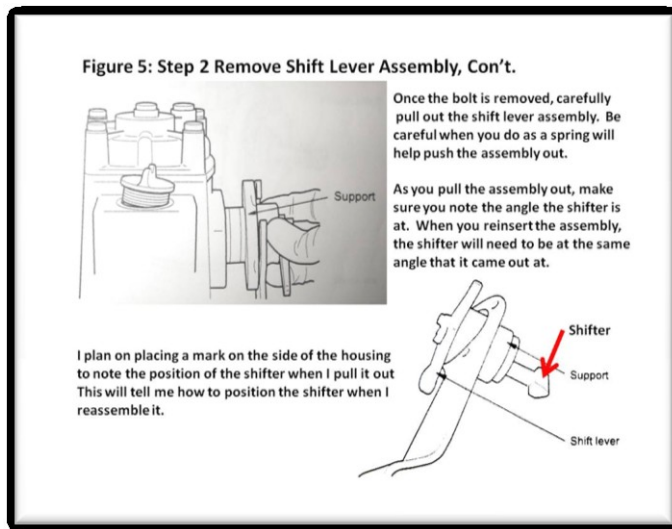
Figure 3 shows the first part of step one. Using a wrench, loosen and remove the four bolts that secure the upper cover cap. Set the bolts aside and remove the cap. Once the cap is removed, you will now want to suck or siphon out about 200 ml of gear oil from the top. You do this so that when you remove the shift lever assembly, gear oil will not run out and get things messy. Once the 200 or so ml of gear oil is removed, you are ready for step 2: removing the shift

lever assembly.

Step 2: Remove The Shift Lever Assembly



NOTE: THE HAND IN FIGURE 4 IS ON ONE OF THE BOLTS. THE OTHER IS THE BOLT THAT IS LABELED "TIGHTENING BOLT".



Now that you have the gear case's upper cover off and you have lowered the gear oil level down below the shift lever orifice, it is time to remove the shift lever assembly. Figure 4 shows what you will be working on and Figure 5 shows what the shift lever assembly looks like. The shift lever assembly is fixed to the gear case by *TWO* bolts. Use a wrench and carefully remove them. Once the bolts are removed, carefully pull out the shift lever assembly. Be careful when you do as a spring will help push the assembly out. *Also be aware that there are shims, or spacers, inside the shifter piston. This is how the factory adjusts the proper tolerances. Just be careful not to dump them out and lose them. We suggest actually wiring, taping, or otherwise keeping the shifter in place inside the cylinder, (labeled "support" in figure 5) that the piston sits in until you are ready to reassemble. As you pull the assembly out, make sure you note the angle the shifter is at. When you reinsert the assembly, the shifter will need to be at the same angle that it came out at. I plan on placing mark on the side of the housing to note the position of the shifter when I pull it out. This will tell me how to position the shifter when I reassemble it.*

Step 3: Loosen Bell Housing Nuts And Push Pinion Gear And Shaft Back

Now is time to do the little secret that saves you time and lots of money. The pinion gear is what transfers the engine's torque to the saildrive and is inside the bell housing. Figure 6 shows the bell housing removed and exposes the pinion shaft assembly. Normally, the mechanic will separate the engine from the saildrive, back the engine off about six inches and back this pinion gear and shaft off. This takes about half a day of his time. However, you are smarter than that! Instead, you need to only loosen the nut that is on each of the 4 stud bolts and back them off until it they are just at the end of each stud bolt. **DO NOT REMOVE THE NUTS FROM**

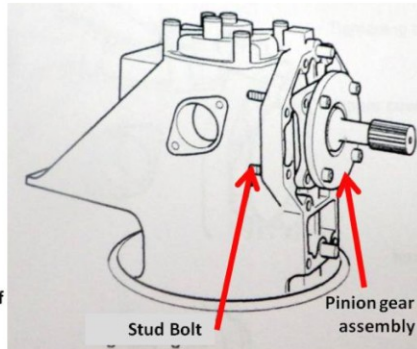
THE STUD BOLTS. *Hint: Count the threads that are sticking out past the nut and record the number to use as a reference when you reassemble.*

Figure 6: Step 3 Loosen Bell Housing Nuts And Push Pinion Gear And Shaft Back

This is where you need to pay attention and not do something stupid like what I would do.

The pinion gear is what transfers the engine's torque to the saildrive and is inside the bell housing

This figure has the bell housing removed and shows the pinion shaft assembly. Normally, the mechanic will separate the engine from the saildrive, back the engine off about six inches and back this pinion gear and shaft off. However, you are smarter than that! Instead, you need to only loosen the nut that is on each of the 4 stud bolts and back them off until they are just at the end of each stud bolt. **DO NOT REMOVE THE NUTS FROM THE STUD BOLTS.** Next, using a hammer, gently tap each bolt to move the pinion gear assembly back a bit so you can easily remove the drive cone assembly (see next figure).

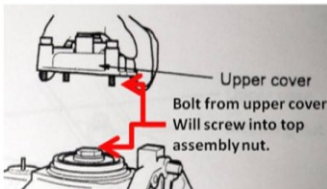


Next, using a hammer, gently tap each bolt to move the pinion gear assembly back a bit so you can easily remove the drive cone assembly.

We discovered it to be much more than a gentle tap, in fact we had to borrow a bigger hammer and used a punch to transfer the blows to the tip of the stud. The hammer could not be applied directly to the end of the stud as the housing was in the way. We also found that we had to back them out to almost their limit (leaving the nuts on) to extract the Drive Cone Assembly.

Step 4 Remove The Drive Cone Assembly

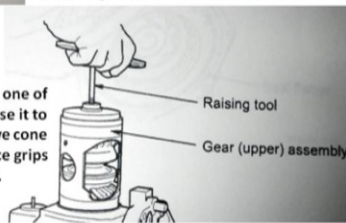
Figure 7: Step 4 Remove The Drive Cone Assembly



The figure to the left shows the exposed top part of the drive cone assembly once you remove the cap. Note the assembly nut at the top of the drive cone assembly that is still sitting in the gear housing. It is threaded at the top so you can screw one of the bolts from the upper cover into the nut at the top of the drive cone assembly to lift it out.

If you like, you can purchase a special Yanmar tool to lift this assembly out.

However, as noted above, if you just take one of the bolts from the upper cover, you can use it to screw it into the nut at the top of the drive cone assembly nut. Then you can use some vice grips to grab the bolt and lift the assembly out.



needed. Instead, just take one of the four bolts that you removed from the upper gear casing cover cap (see Step 1). As it turns out, it has the identical threading as the drive cone assembly's top nut. Thus, all you need to do is screw in one of those bolts, grab it with a pair of vice grips and lift the drive cone assembly out!

Figure 7 shows the exposed top part of the drive cone assembly once you remove the upper gear casing cover cap. Note the nut at the top of the drive cone assembly which is still sitting in the gear housing. It is threaded at the top. If you like, you can go ahead and buy Yanmar's special extraction tool, however, if you are clever, it really is not

Figure 8: Step 5 Disassembling The Drive Cone Assembly

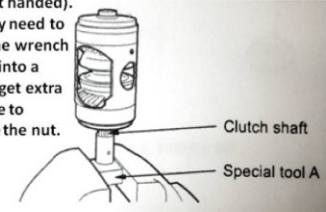


This is what the drive cone assembly looks like once it is removed.

Once you have removed the drive cone assembly you need to insert the clutch shaft into a spline socket so you can insert the socket into a vice without damaging the splines on the shaft. I am not sure what size of spline socket you need but you can buy a universal spline socket set from Sears for under \$40. Or, you can buy Yanmar's special tool A but it is very expensive.

Once the assembly is inserted in the spline socket and you have tightened down the vice, place a wrench on the top nut (it is left handed).

You may need to place the wrench handle into a pipe to get extra leverage to remove the nut.

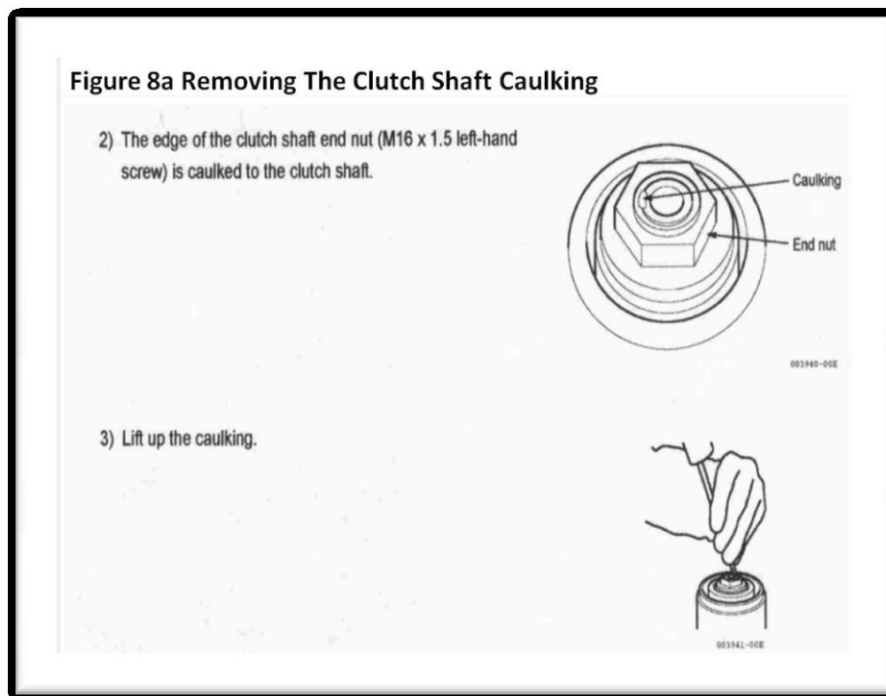


Step 5 Disassembling The Drive Cone Assembly

Once you have removed the drive cone assembly (Figure 8) you need to insert the clutch shaft into a spline socket so you can insert the socket into a vice without damaging the splines on the shaft. I am not sure what size of spline socket you need but you can buy a universal spline socket set from Sears for under \$40. Or, you can buy Yanmar's "Special Tool A" but it is very expensive.

Marie and I bought the spline socket set but it did not work. I believe this is a special spline design because the correct size spline socket would not hold it. I think the teeth on the spline are deeper than the grooves in the socket and the spline spun inside the socket. Fortunately no damage to the spline. Yanmar did not have the Special Tool A in the USA so we bought the part that the spline fits into below the cone drive. It's called a sleeve and is part #196324-04450. It is a simple union (like a butt connector if it were wiring) that is round and identical on both ends, and only costs \$40. A neighbor in our anchorage had a huge vise and we needed it to hold the sleeve. For future jobs we had it welded to a plate we can bolt onto a table to hold it for future jobs. I suggest you buy the sleeve now and not wait for the necessity. You are also going to need to replace the end

nut, part #196324-04380 as you will have to destroy it when you remove it. Let me explain. On the nut is a special "raised ring". Once you torque the nut back onto the shaft you will need a punch to hammer the ring into a keyway on the shaft. To remove the nut you have to pry this peened area out of the keyway. You want to remove as much of what Yanmar calls the "caulking" (peening) in their repair manual, or else you will damage the threads of the shaft when you remove the nut. At the factory Yanmar overdoes the peening such that it is almost impossible to



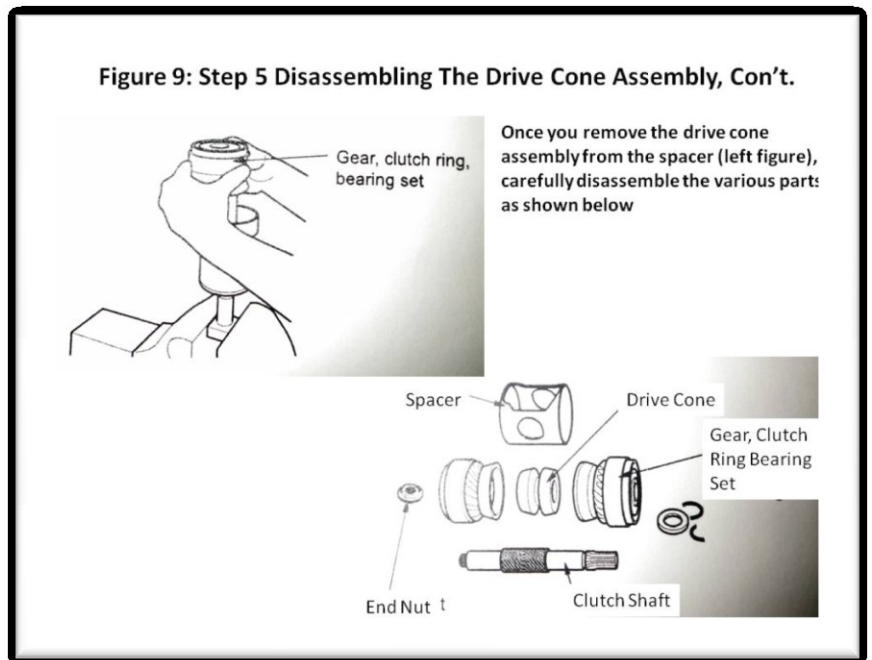
get it all out of the keyway. We did do some damage to the threads but were able to repair them with a triangle file. When we peened it ourselves we did it such that the side of the peening that would prevent the nut from backing off (remember it is a left hand nut so you remove it with a clockwise motion, the opposite of common nuts) is wedged in more aggressively than the opposite side. That will prevent it from backing off, which is what this "caulking" is for, but will allow us to get the chisel under the caulking to pry it up next time. When we do our starboard cone I plan to use a drill to reduce its size and a Dremmel tool to get more of the "caulking" out of the keyway before we back off the nut. Dave suggests you use thread lock but we saw no signs of thread lock from the factory and decided to just use the peening. A note on removing the nut, it is very difficult. We ended up at a machine shop and they could not break it loose with common wrenches or sockets. They ended up using a pneumatic impact wrench. In hind sight I think it was because they did not do a good job

of removing the caulking as demonstrated by the damage to the threads after the nut came off. It is a **27 mm socket** and you will also want to have a 24" breaker bar. It is a **MOTHER** to get off. Fortunately the sleeve for the spline has a thru-hole on each side of it. We needed it to put a pin through (we used a hardened steel punch) because the sleeve being round kept slipping in the vice. Putting a pin through the holes acted like a stop when the sleeve slipped in the vice.

Once the assembly is inserted in the spline socket and you have tightened down the vice, place a wrench on the top nut (it is left handed). You may need to place the wrench handle into a pipe to get extra leverage to remove the nut.



In the absence of the above, I used 2 pieces of aluminum section inserted into the vice jaws as shown in the pic....aluminum is softer than the spline...the spline wasn't damaged at all.



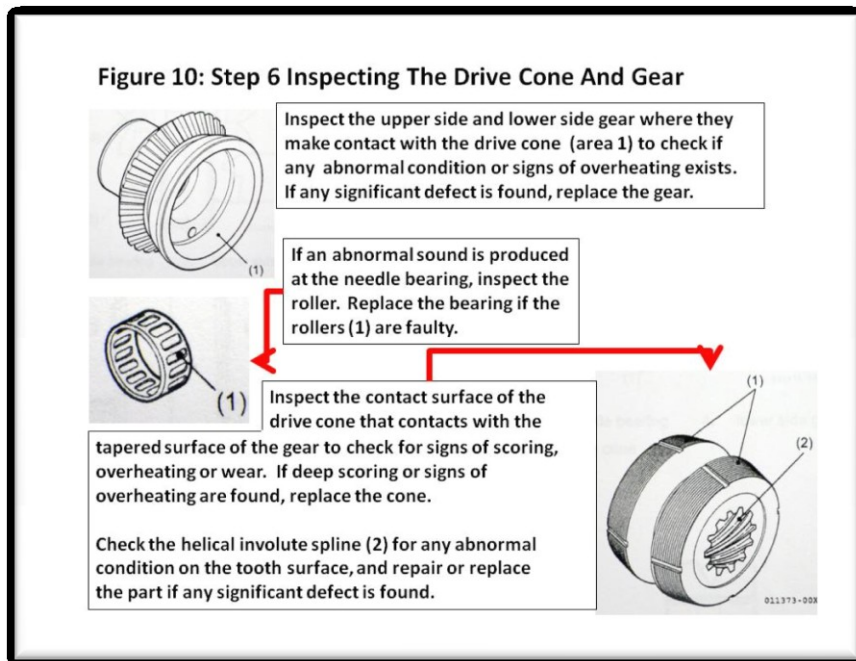
With the nut off, you can slip off the spacer and disassemble the assembly (see Figure 9).

A word of caution here. The circlip semi-circle rings you see in the picture will fall out without you knowing it if you are not careful. You can guess how I know this now. If you lose them like I did you will need two of part #196322-04370 as they are sold individually, not as a set. That number has been superseded by part #04371, but they don't have 04371 in the US as of 9/9/11. So if they tell you they are only available in Japan ask them to look for 04370.

Step 6 Inspecting The Drive Cone And Gear

Once you have disassembled the drive cone assembly, inspect the upper side and lower side gears where they make contact with the drive cone to check if any abnormal condition or signs of overheating exists (see area 1 in the upper left hand picture in Figure 10). If any significant defect is found, you should consider replacing the gear.

Inspect the roller (see the middle picture in Figure 10) and if an abnormal sound is produced at the needle bearing this means the rolls are faulty and the bearing needs to be replaced.



Inspect the surface of the drive cone that contacts with the tapered surface of the gear to check for signs of scoring, overheating or wear (see the bottom right picture in Figure 10). If deep scoring or signs of overheating are found, replace the cone.

Check the helical involute spline (2) for any abnormal condition on the tooth surface, and repair or replace the part if any significant defect is found (see the bottom right picture in Figure 10).

Step 7 Lapping Procedure For Drive Cone

Note: We did not do the lapping but bought a new cone drive for \$432 so I cannot speak to this part of the protocol.

The primary reason most drive cones slip, which causes the problem of not being able to get the saildrive into gear, is that the surface of the drive cone has worn down and is now too smooth to engage the gear. This problem is readily solved by a procedure called "Lapping".

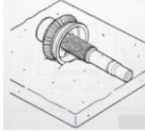
To lap the drive cone you need either lapper powder (use 67 micron silicon carbide #280) or gear paste. Mark Scapens (S/V Isabella) who providing me with the instructions to fix the drive cone gave me a can of Chemico Grinding Paste. In the can are two grades of paste and he uses the fine grade.

Figure 11: Step 7 Lapping Procedure For Drive Cone

Coat the lapper powder onto the cave of the clutch gear (use 67 micron silicon carbide #280, or gear paste).



Set the gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft.



Lap the gear's cave and drive cone, pushing them together by hand.



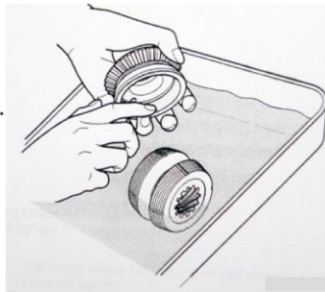
Next, push and turn the gear about 5 times both clockwise and counterclockwise.

Coat the lapper powder or gear paste onto the cave of the clutch gear (see Figure 11, upper picture). Next, set the gear on the clutch shaft with a needle bearing and then set the drive cone on the clutch shaft (see figure 11, middle picture). Lap the gear's cave and drive cone, pushing them together by hand. Next, push and turn the gear about 5 times both clockwise and counterclockwise (see the two lower pictures in Figure 11).

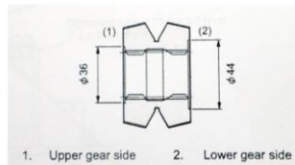
After lapping them, wash them with kerosene or similar solvent. They need to be washed thoroughly so no grit is present (see Figure 12, upper picture). When assembling the drive cone, be sure to check its alignment. The larger diameter 044 face should be on the lower gear side (see Figure 12, lower picture).

Figure 12: Step 7 Lapping Procedure For Drive Cone, Cont.

After lapping them, wash them with kerosene or similar solvent. They need to be washed thoroughly so no grit is present.



When assembling the drive cone, be sure to check its alignment. The larger diameter 044 face should be on the lower gear side.



Step 8 Reassembling The Drive Cone

The tighten torque for the nuts and bolts on the Saildrive cover, attachment nuts to bell housing, and the shifter attachment bolts are all the same (I'm guessing on the shifter bolts because they are the same size bolts and the manual doesn't specify):

14.7 +/- 1.0 N.m (1.5 +/- 0.1 kgf/m) (10.84 ft lbs)

For the end nut on the Cone Drive shaft it is ten times this amount or:

147 +/- 5 N.m (15 +/- 0.5 kgf/m) (108.42 ft lbs)

Pay close attention to the picture at the bottom of Figure 12 (above), it is important that the clutch be installed correctly as it will fit just fine upside down but I'm guessing it won't work, at least very well. Once it is off you will see it is different on either side. According to figure 12 the wider faced side goes down toward the spline end of the shaft. The same is true of the spacer, but you can tell from Dave's picture in Figure 8 which way it goes. The small hole above the shifter opening is the clue to verify with, it goes toward the nut end of the shaft.

You are now ready to put everything back together again. To do this, look at Figure 5 (above) and reassembly the drive cone assembly. Once assembled, reinsert it back into the drive cone spacer. Place the spline socket back onto the shaft and put the entire unit back into the vice and tighten the vice. When you tighten the top nut use a little Loctite (red) along the threads. Reinsert the drive cone assembly back into the gear housing.

It should be obvious, but I'm learning not to take anything for granted, that the large hole on the spacer faces the pinion gear, and the smaller "perfect circle" faces the shifter.

Tighten the four nuts on the stud bolts that are still in the bell housing to bring back the pinion gear assembly back into place. *Marie turned each nut until it offered resistance and then moved on to the next one.*

Reinsert the shift lever assembly making sure the shifter is at the same position that it was when you removed it. This is where your mark on the housing can help. Tighten the tightening nut.

Critical: The shifter in Figure 5 is not symmetrical. One end of the lobe is fatter than the other end. The fat end goes aft. If you reassemble wrong like we did the first time it will not go into gear.

Replace the gear cover and tighten the four bolts and replace the gear oil that you drained.

Open a beer, take a big swig and then start up the engine and put the engine into gear and pray! If all went well, your prop is spinning in gear and you are under way. If not, oh well, you are no worse off than before and you only spent a few hours of time. You can always call the mechanic and get out the loan application to pay for the big dollars he will be charging you!

Our unhappy ending. It didn't work for us. We put it all back together and put it into gear. The prop spun but as soon as we gave it some RPM it slipped and we lost thrust. This is exactly the symptom we had before we started the procedure. It turns out that Flex'O'Fold props are rubber damper mounted similar to an outboard

rather than spline mounted. Unfortunately we ASSumed they were spline mounted by their appearance...but lo and behold, after checking with the manufacturer they are indeed rubber mounted.

Write-up would not be complete without giving credit and undying adulation to our Admiral Marie. Every man should be so lucky.



When we were refilling the gear oil one of the hoses came loose and hosed Marie down with 90 weight. She yelped then jumped out of the engine compartment and laughing told me to grab the camera, she had earned her stripes as a Grease Monkey and wanted it documented:



Attitude....the difference between an Ordeal and an Adventure.