

<http://www.sailblogs.com/member/leucat/?xjMsgID=184004>

Background and Introduction:

Thanks to Mark Scapens (S/V Isabella, Lagoon 440, hull # 96) Of Tauranga, NZ, I now have a step by step set of instructions on how to repair a slipping drive cone in my Yanmar SD 50 saildrive. Note: some people call it a cone drive but the Yanmar saildrive repair manual I have calls it a drive cone. Therefore, I shall be referring to it as the drive cone.

I have written down Mark's instructions and added figures that show you how to do each step of this repair. 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 all day for him to do it. This will cost you virtually nothing and should only take a few hours of your time.

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. I will ask Mark to review what I have written here and, if any changes are needed, I will announce the changes in a future techno-tip and will go back and correct the information as currently written. It may be a while before Mark gets what I have written and reviews it since they are in a remote part of the Yasawas in Fiji and there is not Internet. I have decided to offer these instructions now instead of waiting in case someone needs this information now instead of later. 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.

Alright, with that background and introduction, let's get started.

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

Figure 2: Close-up View Of What You Will Be Working On

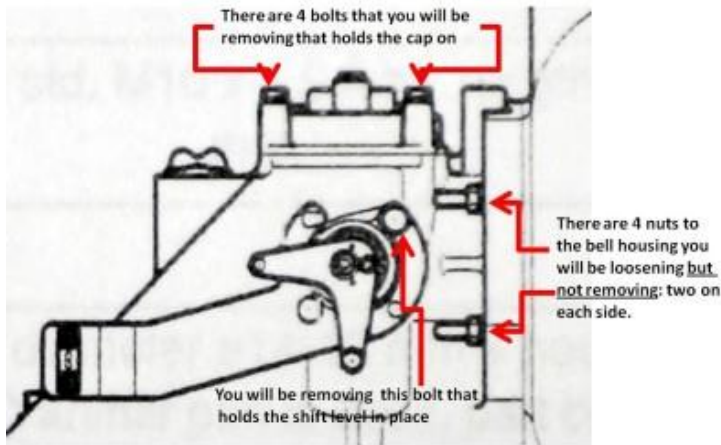


Figure 1: Side And Top View Of Yanmar SD 40 or SD 50 Saildrive

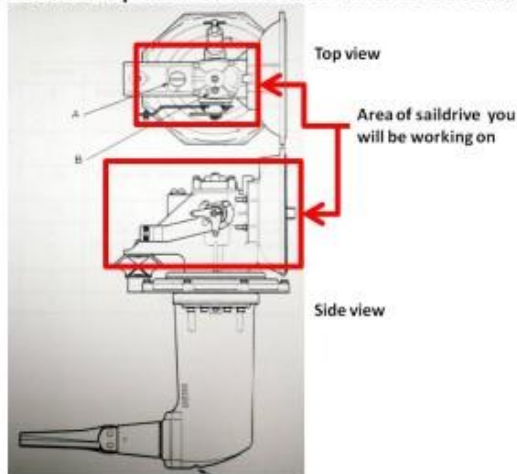


Figure 1 shows the side and top view of the saildrive and highlights the area of the saildrive you will be working on. Figure 2 is a close up of the area of the saildrive you will be working on. It also shows the bolts and nuts that you will be removing or loosening. The secret of not having to separate 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.

The symptom that you will 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.

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

Figure 3: Step 1: Remove Upper Gear Tightening Bolts (4) And Upper Gear Cover

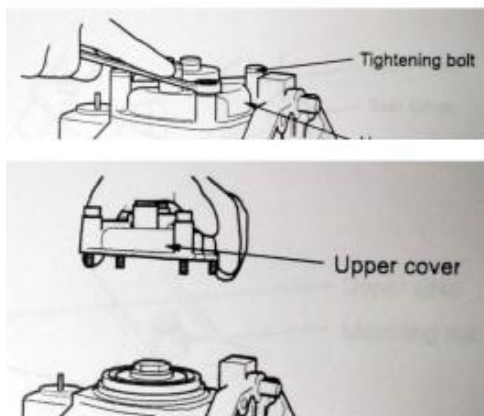


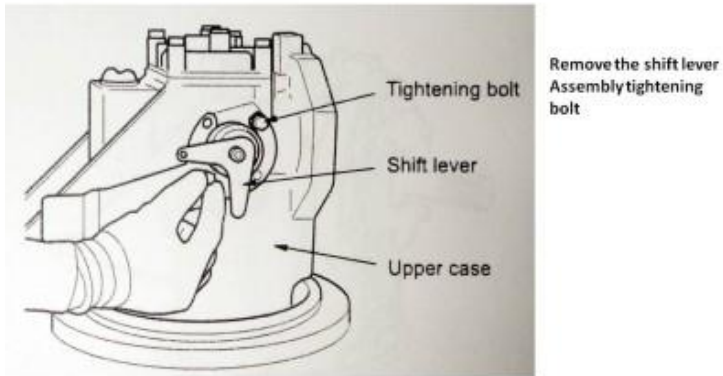
Figure three shows the first part of step one. Using a wrench, loosen and remove the four bolts that secure the upper cover cap. Set the bolts aside and remove the cap. Once the cap is removed, you will now want to suck or siphon out about 200 ml of gear oil from the top. You do this so that when you 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, which is tomorrow's techno-tip of the day.

This picture is looking down onto the gear box after removal of the cover cap



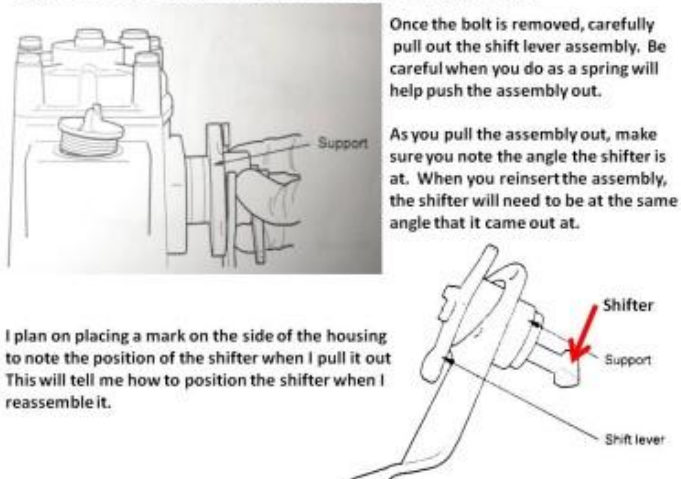
Step 2: Remove The Shift Lever Assembly

Figure 4: Step 2 Remove Shift Lever Assembly



NOTE: THE HAND IN THE FIGURE IS ON THE WRONG BOLT. YOU WANT TO REMOVE THE BOLT THAT IS LABELED "TIGHTENING BOLT".

Figure 5: Step 2 Remove Shift Lever Assembly, Con't.



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 a single bolt.

Use a wrench and carefully remove it. Once the bolt is removed, carefully pull out the shift lever assembly. Be careful when you do as a spring will help push the assembly out. 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.

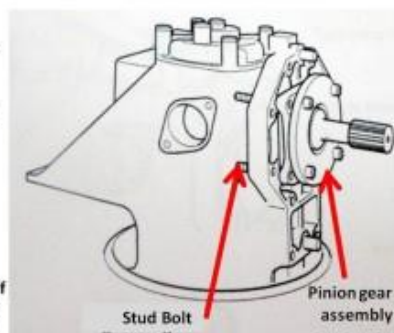
Step 3: Loosen Bell Housing Nuts And Push Pinion Gear And Shaft Back

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

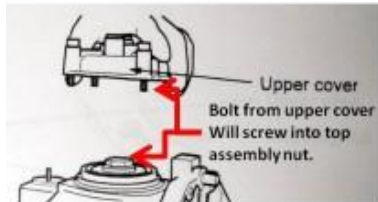
This figure has the bell housing removed and shows the pinion shaft assembly. Normally, the mechanic will separate the engine from the saildrive, back the engine off about six inches and back this pinion gear and shaft off. However, you are smarter than that! Instead, you need to only loosen the nut that is on each of the 4 stud bolts and back them off until it 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).



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.** 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

Step 4 Remove The Drive Cone Assembly

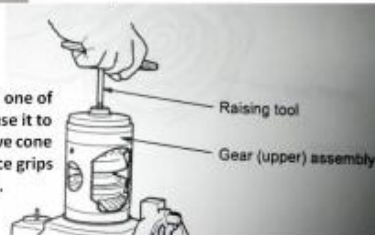
Figure 7: Step 4 Remove The Drive Cone Assembly



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. Then you can use some vice grips to grab the bolt and lift the assembly out.



Before moving the assembly, use a felt pen to mark the assembly and the gearbox housing. This will assist lining up the assembly when re-inserting it (see step 8)

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 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!



Step 5 Disassembling The Drive Cone Assembly

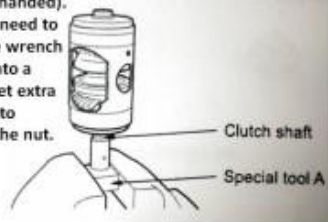
Figure 8: Step 5 Disassembling The Drive Cone Assembly



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.



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.

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

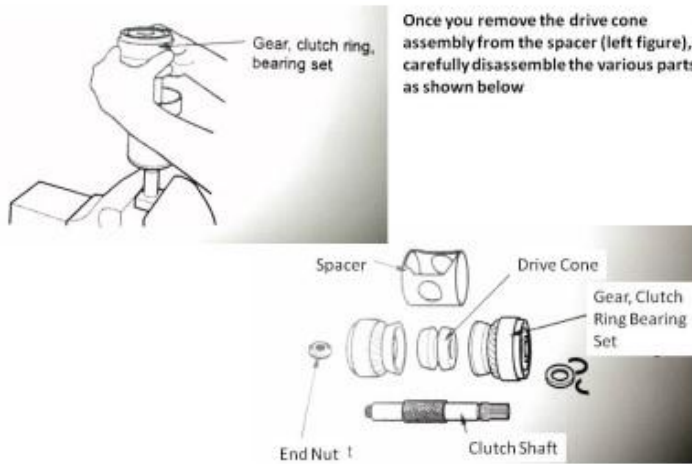


Once the assembly is inserted in the spline socket and you have tightened down the vice, place a wrench on the top nut (it is left handed). You may need to place the wrench handle into a pipe to get extra leverage to remove the nut. (I think a 27 ml socket fits)

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

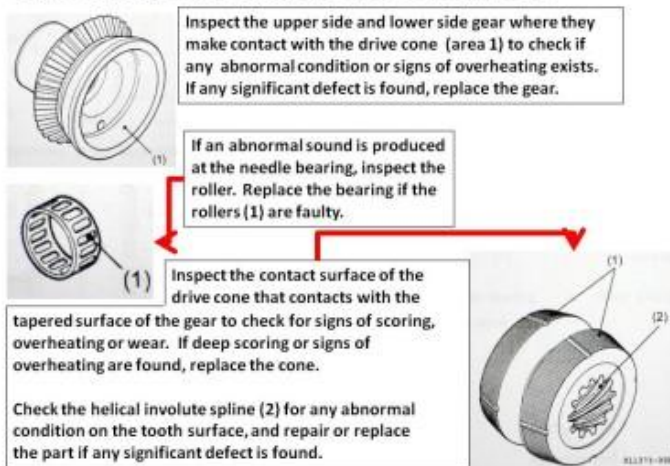
NOW ITS TIME TO GO SLOW!!! Make sure you use a system to layout the parts in some sort of order. We used a scribing tool to mark the "top" of the 3 gears and cone.

Figure 9: Step 5 Disassembling The Drive Cone Assembly, Con't.



Step 6 Inspecting The Drive Cone And Gear

Figure 10: 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. Oil is "squeezed" into the horizontal grooves on the cone when it's engaged. If the ridges have been worn flat, then the cone will definitely need replacement.

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).

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.



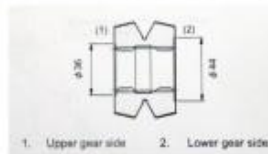
Next, push and turn the gear about 5
times both clockwise and
counterclockwise.

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

You are now ready to put everything back together again. To do this, look at Figure 5 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.

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.

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.

There's a good chance the locking tang broke away when you were first undoing the nut. If you don't have a new nut (as we didn't), we used Loctite #xxx, and tighten the nut back to its original position by aligning the missing tang stub and the slot on the shaft.

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 to 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!

Techno-Tip of the Day: Update on the Drive Cone Repair Procedures

I received an email from a Craig, another Lagoon 440 owner. He had read the series of techno-tips that I posted on repairing a worn cone drive in the Yanmar saildrive. He said that he will be attempting to repair his drive cone tomorrow and will let me know how it goes. He also shared with me that he spotted a typo regarding the torque that should be applied to the various nuts that one has to tighten when putting everything back together. Apparently, I had written that the nuts need to be tightened to 1.5 kgf/m torque. This is in error. I should have written that the nuts need to be tightened to 15 kgf/m torque. I apologize for this mistake and will be correcting this error in the blog once I have Internet access again. If anyone has followed this procedure and used only 1.5 kgf/m torque in tightening the bolts, you better go back and retighten them properly!