Part #55

C & E Gearbox Maintenance – Basic Teardown & Inspection

By Mike Stratman

Last time we covered the teardown and maintenance of the popular model "B" gearbox. As we found, with a minimum of specialty tools and fixtures the average Joe can perform much of his own work. When it comes to the model "C" and "E" gearboxes things are a lot more complex and specialty tools are absolutely a necessity to accomplish a number of important tasks. In the event of a severe prop strike it is highly recommended to teardown and inspect both crank and propshaft for run out. This month we'll perform a step-by-step teardown and inspection of both models. We'll discuss a couple of important production changes you need to know about and well as cover the tools and fixtures that you will have to have on hand before performing surgery. Also we'll introduce an aftermarket product that has really caught on with model "C" gearbox owners.

What is the reasons for going to a model "C" or "E" gearbox instead of a model "B" ??: *This question is really quite simple. Your selection of propeller determines which gearbox you will need. The general rule to follow is that a model "B" gearbox can handle anything up to a 68" two blade or a 64" 3 blade prop. Anything larger than this and the "B" box will not handle the load properly. Smooth idle will begin to be in excess of 2000 rpm and starting will be come more difficult. At lower rpm's the engine will shake excessively due to the gearbox's design limitations. If you wish to run larger diameter props at slower speeds you must go to the "C" or "E" boxes. Remember the general rule that a big prop turning slow is quieter and more efficient than a small prop turning fast. These boxes use a rubber hardy disk to absorb the extra stresses caused by prop inertia. See Part #31 "Measuring Prop Inertia" for more info on gearbox limitations.*

Internal these boxes are much the same with the exception of an internal electric start in the model "E". This allows for a lighter and more compact system when compared to magneto end electric starters. It also allows you to retain the stock recoil starter for back-up purposes.

Determining the Ratio of Rotation: *There are several ways to determine which ratio your particular box is. The factory stamps this info on a flat area on the outer case housing. It would be best to confirm is info with another check because the vendor selling the box may change the gear set. Mark the hardy disk inside the large opening on the inner case with a piece of white caulk. Record the rotations of the prop needed to complete one revolution of the hardy disk. This should give you one of the following ratios. 2.62, 3.0, 3.47, or 4.0 to 1 revolution of the crankshaft. Another way the determine the ratio is to count the number of teeth on both gears and divide the number of teeth on the large gear by the number of teeth on the small gear on a calculator. Example: 55 / 21 = 2.619 or 2.62 ratio. The following is the tooth count of the four ratios available:*

Ratio	Small Gear	Large Gear
2.62	21 teeth	55 teeth
3.00	19 teeth	57 teeth
3.47	17 teeth	59 teeth
4.00	15 teeth	60 teeth

Figure #1 – This centrifugal clutch takes the place of the flywheel and rubber doughnut in the model "C" gearbox. Unit disengages below 2500 rpm. For easy starts and smooth idles. Not a Rotax factory product.

***Model "C" Gearbox Clutch**: The aftermarket has come up with a very slick centrifugal clutch option for the model "C" box. This unit is an easy bolt on conversion that takes the place of the stock flywheel, hardy disk, and three-arm spider assembly. At 2500-rpm centrifugal force causes internal brake shoes to contact an outside drum that in turn starts the prop rotating. This does wonders for the operation of the entire aircraft. Start-up is no load and real easy, pulling thru the compression of the pistons only. Idle is extremely smooth and low, really low, like down to less than 500 rpm. This is ideal for easier descents. The prop now acts as a brake as it free wheels at low rpms instead of extending the glide when you throttle back. Ground handling for floatplanes is much easier as you can let the engine idle without the craft being pushed around on the water. The addition of the clutch generally makes the plane a lot quieter and easier to handle on the ground. Much larger props with more blades no longer produce the low rpm problems because the engine is no longer hard linked to the prop. See figure #1 for illustration. Sorry, it doesn't work on the "E", as the starter motor would be turning the prop only.*

Figure #2 – Get started by draining the oil by removing the magnetic drain plug.

***Drain Oil and Inspect Plug**: Get started by draining the oil by removing the drain plug. The periodic maintenance chart schedules replacement of the oil after the first 10 hours and then again every 100 hours. Because the plug also has a built-in magnet which collects any metal filings that may be present. Small particles are OK. Big chunks obviously require you to inspect farther looking for the source. Next remove the rack of 6mm bolts that hold the two case halves together. Tap the case halves gently apart with a rubber hammer. On the model E box the gears, sprag clutch, and shims need to be set-aside in the order they are removed so they can be returned in the proper order.*

Figure #3 – A long reach Allen wrench is need to remove the bolt hidden down inside the small drive gear.

Removing The Engine Side Case Half: *Once the cases are split you need to remove the small drive gear with a long reach Allen wrench as shown in figure #3. Install your fixation pin in the pulse port as shown in figure #5 to prevent the crank from turning. This pin can be found in the tool kit that comes with every new engine. Order #876-640 if you can't find yours. Use anything else and you take a huge risk that the pin will bend and subsequently can't be removed without damage to the crankcase or brass pulse port. At this point you are ready to remove the 8 case bolts located both inside the box as well as outside the case. See figure #4.*

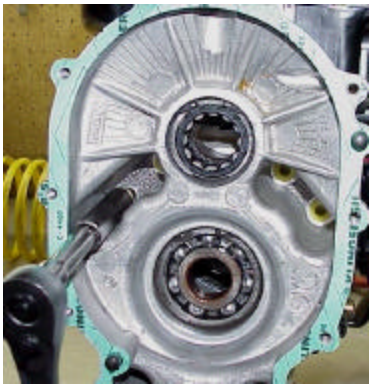

Figure #4 – Remove the 8 case bolts, four inside and four outside the box to remove the entire case half from the block.

Removing the 3-Arm Spider Assembly: *Once the housing is removed you need to inspect the rubber doughnut or hardy disk closely for cracks or fatigue. Also check the disk for the hardness number. All new units are a #75 hardness. Older units maybe a #65 or #55. The steel band shown in figure #4 is on all new disks to help compress the disk for better bolt alignment during installation. Use a 5" hose clamp to compress the disk if necessary. Always remove band after installation. Leaving it on during operation is not an option as this will prevent the disk from functioning properly and will eventually destroy the disk.*

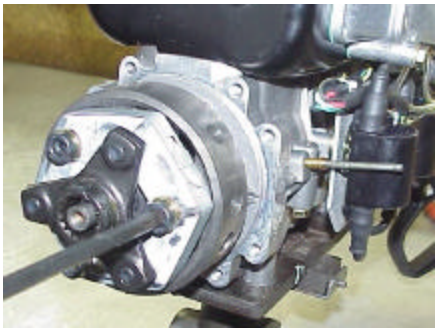

Figure #5 – In order to change the crankshaft, the spider, hardy disk, and flywheel need to be removed. Note fixation bolt in pulse port to prevent crank from turning.

Remove the Flywheel: *The puller shown in Figure #6 is ideal for removing the flywheel. If you have a magneto end flywheel puller it will work here as well. The bolt pattern is the same.*

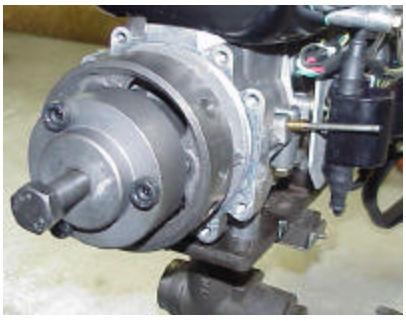

Figure #6 – Pulling the flywheel requires the right puller. Your magneto puller works here as well. A large 3-jaw puller is also an option.

At this point you are as deep into the box you are going to go without a number of specialty tooling. Next month we'll show you how to change gears sets, remove the propshaft, do a complete inspection, and update your box following the latest Rotax Service Bulletins. We will also illustrate several special jigs that need to be fashioned to perform certain tasks.

Part #56

C & E Gearbox Maintenance - Changing Gears & Propshaft

By Mike Stratman

Last time we talked about general teardown and inspection of the "C" or "E" Gearbox. As we found that with basic hand tools and your mag-end flywheel puller you can get at a majority of the gearbox. But if want you to change the gear ratio or propshaft your are going to have to invest some time and money on the right equipment. This month we will illustrate several special jigs that need to be fashioned to perform certain tasks. We'll show you how to change gear sets, remove the propshaft, do a complete inspection, and update your box following the latest Rotax Service Bulletins

Pulling the Large Gear: *Here is where things start to get tougher. In order to remove the large hex nut and pull the gear you will need both a solid fixture to mount the prop shaft as well as a special puller from Rotax to actually pull the gear from it's tapered fit. In order to get a firm grip on the prop flange, construct a jig using the prop plate for a pattern. You will need 6@ 1-1/2" long 8mm studs (5/16" will work as well) mounted thru a metal plate with a 1" center hole. See figure #7.*

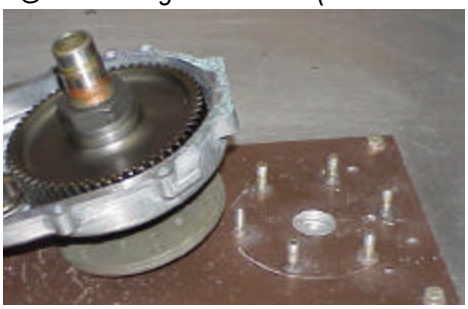

Figure #7 – Holding the prop shaft in a jig is necessary to remove the large nut holding the gear in place. A simple jig mounted to a workbench is needed to handle the large torque values.

Removing the Large Nut: *Once you have the propshaft firmly held, you can remove the 30mm nut on the shaft. Good luck trying to find a metric socket big enough to fit. A 1-5/8" socket will work as well. You will likely need to go to ¾" drive to fit this large socket.* ***Remember that the threads here are Left Hand!!*** *You may need heat to soften the Loctite on the threads. We use a 6'long iron pipe for a cheater bar to help get the snort needed handle this job. See Figure #8.*

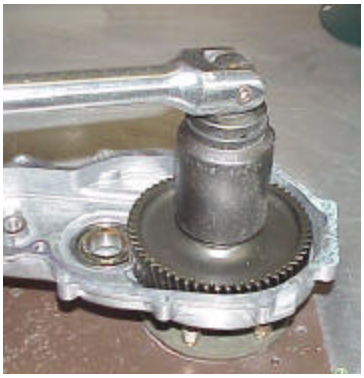

Figure #8 – Using a ¾" drive breaker bar and 1-5/8" socket remove the large nut which is ***Left Hand Rotation!!***

Removing the Gear: *Here is where you will have to suck it up and buy the right tool to pull the large gear. Rotax #877-375 Puller is the only way to get a hold of this gear. Currently the cost is around $95.00. You also need #877-415 protection cap (currently $17.00) for where the puller meets the prop shaft. The puller threads on to the gear and supplies a direct even pulling force. But before you attach the puller heat the gear center aggressively with a hand torch powered by Mapp Gas or hotter. Here is where a little butane torch is not going to cut it. You must get the Loctite to 450F to get it to let go. Anything less and forget it! All you'll do is pull the threads out of the puller. Yes, you can actually wreck the puller if the heat is not sufficient. Only after you are sure you are hot enough install a cold puller all the way down and apply pressure. When reassembling this area the call out by Rotax for this area is Loctite 648. Good Luck finding this particular number locally. It is a European number that most suppliers will not recognize. What you need is a high strength sleeve retainer applied to both the shaft, cone and inside gear surface as well as the threads. CPS carries it under part #9655.*

To remove the split-tapered cone left on the shaft, use a large flat head screwdriver to ply open the collar enough to slide it off.

Figure # 9 – Use of the right Rotax puller and lots of heat is the only way you're going to get the large gear off the propshaft.

Removing the Propshaft*: In order to replace or inspect the propshaft oil seal the shaft must be pressed out from the inside. This requires a fixture that supports the front housing in the press. Rotax makes no tooling to address with procedure. Figure #10 shows both "C" and "E" fixtures that we custom made from plywood and angle brackets. While these jig looks like a lot of work an improperly supported housing will fracture during the pressing process. The cost of housings are in the $400-$500 range so think about investing the time in a custom fixture that you feel comfortable will not put the housing at risk. The model "C" fixture is a little easier just needing angle brackets that support enough of the bolt bosses to form a level plane to support the housing. The large 4-1/2" hole in the center allows for propshaft clearance and travel. The model "E" fixture is a little more complex because you need to support the housing area around the propshaft in a cradle that conforms to the contour of the housing. Again a 4-1/2" hole plus addition relief for the sprag clutch area needs to be fashioned. See Figure #10 and #11 for jig in use.*

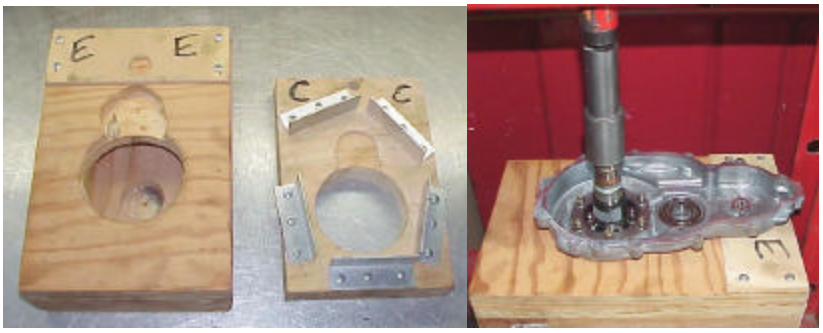

Figure # 10 & #11 – Shows both "C" and "E" custom fixtures need to support the housing during propshaft removal. If not properly supported the housing will break under the pressures needed to remove the propshaft.

Removing the Propshaft Bearing and Seal: *At this point the propshaft is out of the way and the support bearing and seal can be removed. After removing the rack of 6mm bolts holding cover plate. To remove the bearing, press from the opposite side pushing the seal and bearing out together. This will likely destroy the seal so be sure to have another on hand if you need to go this far. If you have suffered a severe prop strike you need to check the propshaft and the crankshaft end for run out. The maximum run out is .002" or 0.05mm for either. If the propshaft is bent it is best to replace this bearing as well as the seal figuring that the bearing would likely be damaged as well.*

Figure #12 – Be sure to install the Bushing/Collar in the bearing located next to the large gear. On some ratios this cannot be done after the gear is in place.

Front Housing Drive Gear Bearing: *Locate next to the large gear is a bearing that supports the outside end of the small drive gear. Special attention needs to given this bearing for a couple of reasons. First. The collar that contacts the shaft is both a bushing as well as part of the bearing and can be separated from the rest of the bearing. At this point the actual bearing rollers are no longer supported and can fall from the race. It's OK to use a light grease to keep these guys under control during assembly. Also make sure that the collar is back in place before reinstalling the large gear. On some ratios you can't do this after the gear is in place. See Figure #12. If for whatever reason you need to remove this bearing completely, heat the housing aggressively from the opposite side to expand the housing. Slap the entire housing down on a piece of wood to extract the bearing by force.*

Important Production Changes: *Due to some early problems with large gear slippage on the propshaft the tapered cone inside the large gear has been changed to a different taper on both the large gear and the cone sleeve. If you own one of the first "C" or "E" boxes it will have a different type of gear and cone. Early models, especially the higher 3.47 and 4.0 ratios, had trouble with slippage making it necessary to go to huge torque numbers on the shaft nut. If you have one of this older units refer to Service Instruction Bulletin #SI-06-98 found on our website at www.800-airwolf.com. Go to Tech Info and then Rotax Documentation. Download in PDF format. Be sure to use Loctite High Strength Sleeve Retainer #648 or #680 inside and outside the cone sleeve as well as on the threads to keep your assembly from slipping. Torque large nut to 185 ft. lbs or 250 NM.*

Figure #13 – New gearbox come with an improved spider and matching seal. Be sure not to mix old and new style spiders and seals. Leakage will occur.

New Spider Gear and Seal: *Also be aware that the spider part # 958-971 has been changed slightly requiring the use of a different seal #950-084 for better sealing of this area. The new spider has an identifying mark on the outer ear as shown in figure #13. See bulletin SI-2ST-004 issued in December 2001. Full document can be found on our website at www.800-airwolf.com. Go to Tech Info and then Rotax Documentation.*

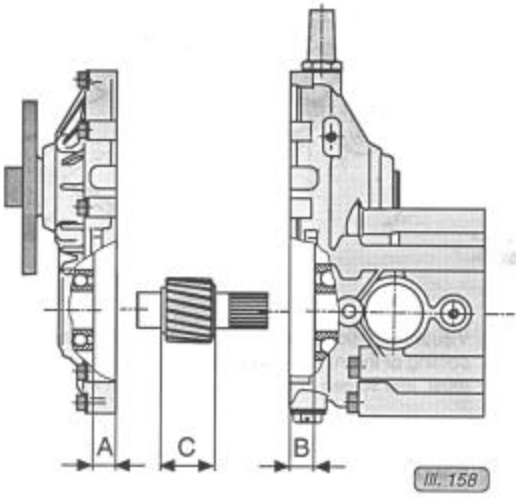

Figure #14 – Because our gears are helical cut they will want to move in either direction when load is applied and released. Proper clearance between case and gear needs to be maintained.

Shimming for Small Gear Clearance: *Because the gear teeth are helical cut they will want to move in either direction as the load is applied and released. Proper clearance between the case and gear needs to be addressed. To determine shims needed, take dimensions by depth gauge from jointing plate of housing and cover too bearing. Add dimensions A and B and compare with dimension C as shown in figure #14. Compensate with shims as shown in parts book located on the engine side of the gear shaft. You are looking for a zero differential. The thickness of the large case gasket is 0.4mm, which supplies the final clearance when assembled. Chances are the clearance is OK if you reinstall the shims present when you disassembled the box. Boxes with very high hours will likely have shimmed due to normal wear. Left unattended the gear will wear at an accelerated rate the more slop is available so pat attention to this clearance during regularly scheduled inspections.*

Preflight and Periodic Inspections: *Make it a habit to include the rubber hardy disks on your daily preflight. Use a flashlight thru the large inspection hole to view the rubber disk for cracking or deterioration. The disk should give you plenty of warning as it begins to chuck out before complete failure. Under no circumstances are you to cover or block this opening. It must remain open for proper ventilation and cooling of the enclosed parts.*

Be sure to change the oil with a good SAE 90 W GL-5 oil after the first 10 hours and every 100 hours thereafter. Drain and replace annually to eliminate the water condensation that will build up from normal operation. Remember, these gearboxes are relatively trouble free given a minimal amount of attention.