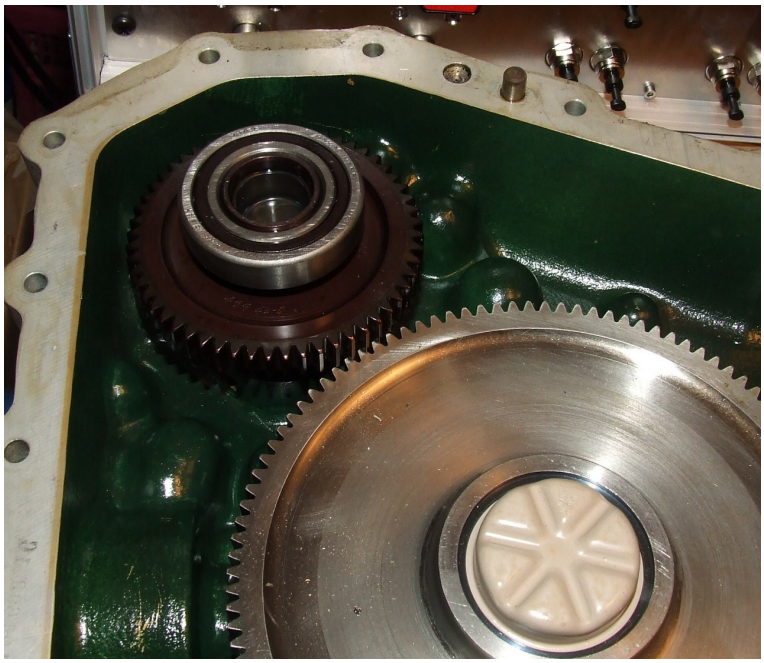
Solar T-62T-32 Gearbox Modification

To Accomodate Alternator Opposite to the Starter

Many Applications of the Solar T-62T-32 turbine engine in amateur built aircraft benefit from an alternator that is being driven directly by the accessory drive system of the engine. Especially, this means that onboard electricity is generated while the engine is running at ground idle and the (centrifugal) clutch that's part of many installations, is not engaged.

Since the standard configuration of the engine doesn't provide a spare auxiliary drive pad, we evaluated a modification to make exactly this available. Be aware that this job is nothing for the faint of heart and substantial tooling is required (and the experience to use it properly...).

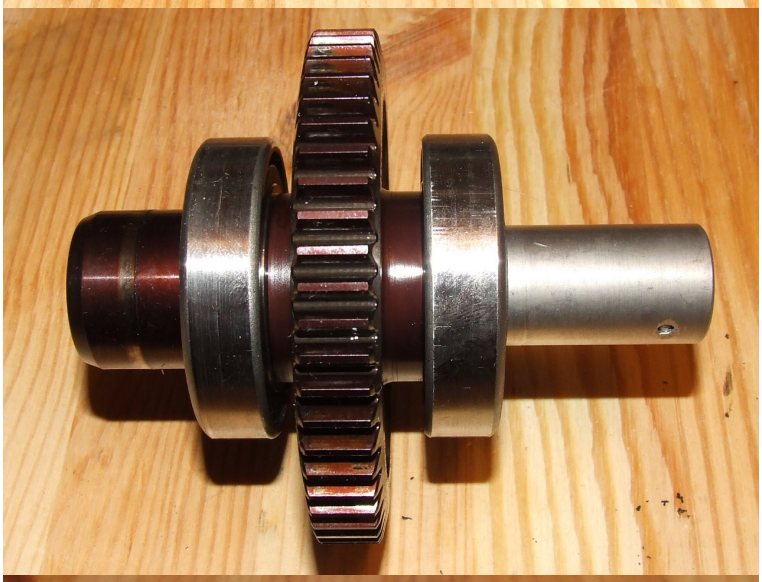


Disassembly of the engine starts with draining of the oil, then the wiring loom and the plumbing is removed. After that, the intake screen is removed and the nuts that hold the power head to the gearbox are taken off. Depending on the type of nuts used, the struts of the intake housing may be in the way to remove three of the nuts completely. If this is the case, the power head has to be gradually pried off while removing the remaining nuts (there are four threaded bores in the intake housing flange to insert pry bolts in order to remove the power head from the planetary gear spider). Be careful to properly support the power head when it finally gets free as not to apply the weight of the engine through the pinion gear and shaft. Now remove all accessories. Take utmost care when working at the throttle control linkage since the throttle valve shaft inside the fuel control unit is very likely to fracture if it's subjected to too high force. Place marks on all the components so you will be able to get everything together again in exactly the same orientation.

When the gearbox is finally stripped of all its attachments, place it on a flat surface, drive pad facing down, and remove all the nuts and bolts holding the two castings together. Use four pry bolts in the threaded holes of the planetary gear spider to remove it from the upper gearbox casting. If you haven't got a replacement, be careful not to damage the O-ring located in a groove of the spider. In the rear (now upper) half of the gearbox casing, there are three threaded holes next to the alignment pins. Insert screws here to pry the two halves apart, applying the same amount of

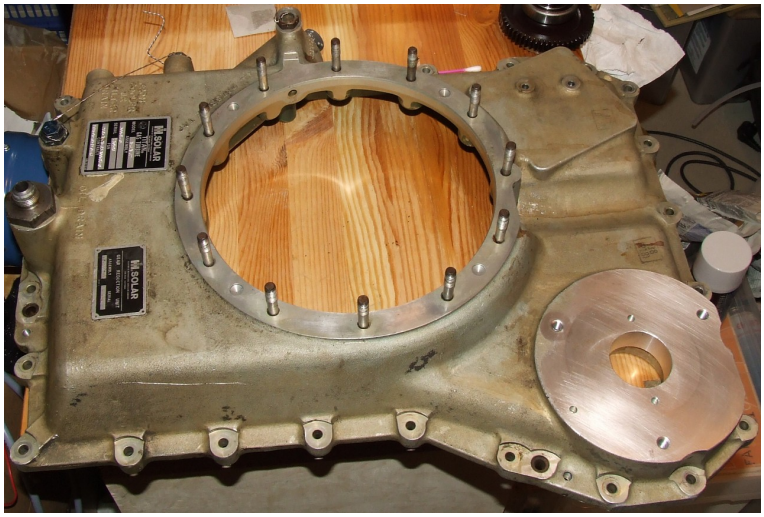
turns to each so the halves separate parallel from each other. Once the halves are three millimeters or so apart, you can try to use a blunt knife to separate the gearbox gasket from the mating surfaces. If you are lucky, you may get the gasket free in once piece. If not, you'll have to source or cut a new one before reassembly. Lift the upper casting off of the lower.

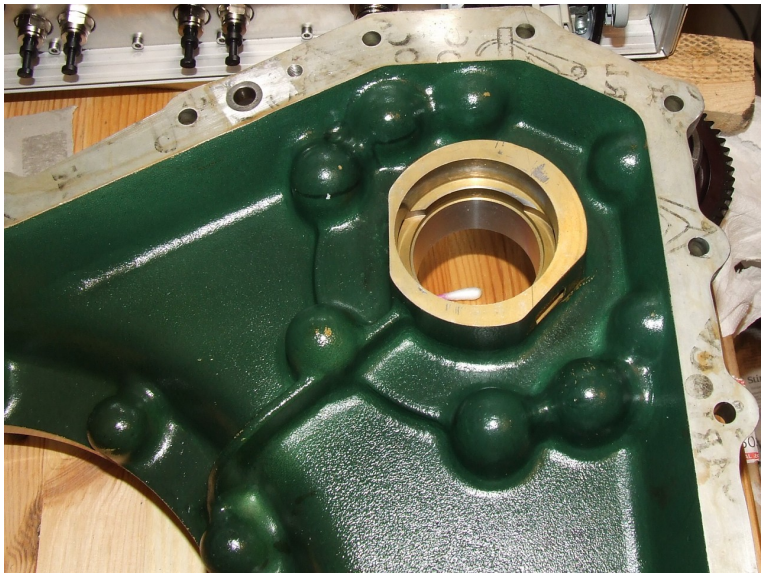
Now you should have something like shown in the first picture (previous page). Pull the starter gear and use a wooden or soft-metal drift and drive out the pressed metal plug, away from the splined area. During this procedure, do not support the gear through the outer race of the rear bearing!



You may now test insert the splined alternator adapter into the starter gear from the rear. The spline is quite a close fit and it may not easily mate with the female spline of the starter gear. If it's oriented and positioned properly, it should smoothly slide in. The Viton O-ring seal in the groove of the alternator adapter will seal the gearbox towards the starter, effectively replacing the metal plug you removed before.

The torque is transferred to the (modified) alternator shaft via a radial pin mating a slot in the alternator shaft. The pin provides a “shear point” in case something goes terribly wrong with the alternator (seizure). By shearing off, it effectively decouples the alternator from the engine and permits continued operation of the engine for its “real purpose”. The cavity with the shear pin is sealed from the gearbox cavity by another Viton O-ring that mates with the alternator shaft. This cavity should be filled with grease upon assembly.





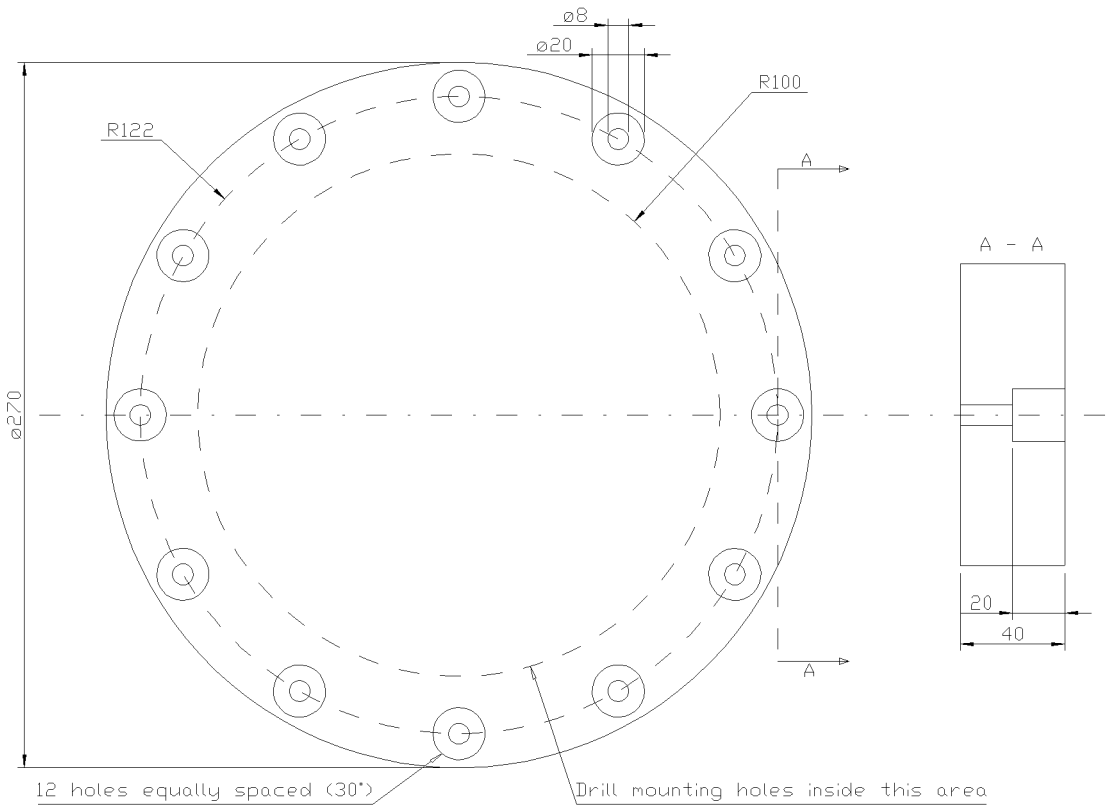
In order to accommodate the alternator, the (now removed) rear/upper gearbox casting needs to be modified. The photos show an already modified casting but the procedure is straight-forward.

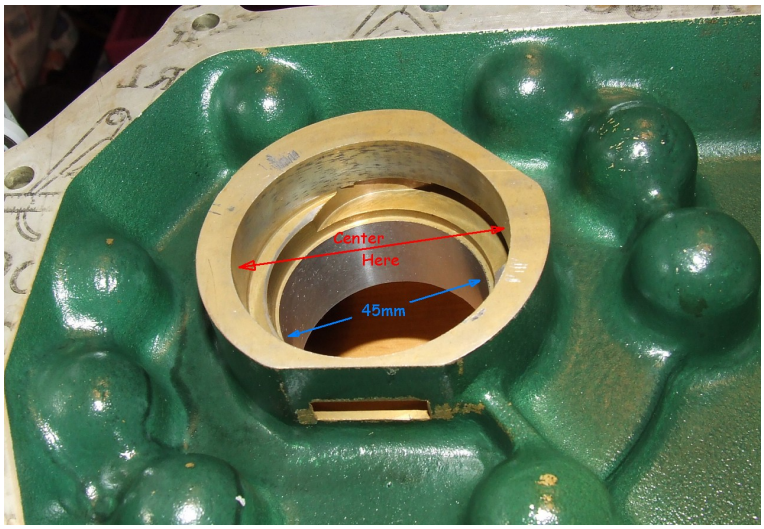
Basically, the gearbox casting needs to be machined right through, exactly concentric to the rear starter gear bearing seat.

The second modification will be machining a flat surface, parallel with the split line of the gearbox, where the alternator will be bolted on. This is the area where originally the ignition exciter was located.

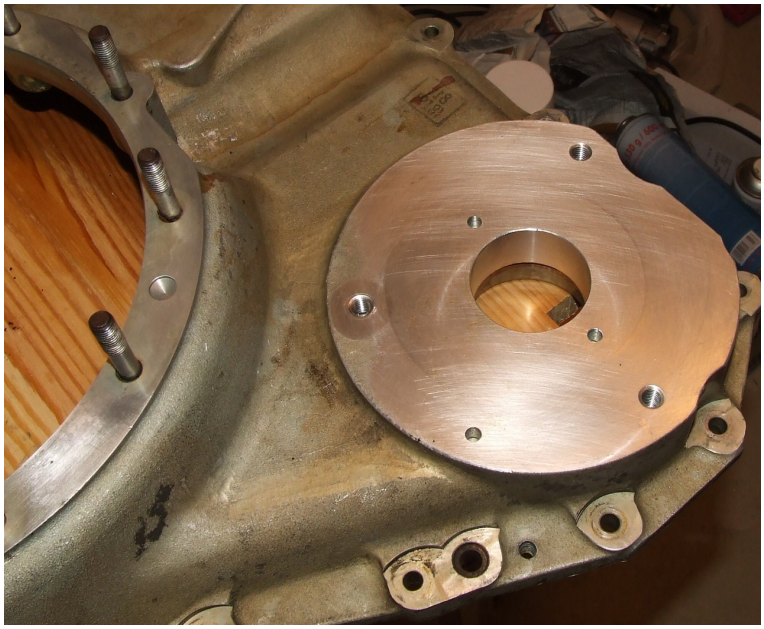
Finally, the holes that accept the alternator mounting bolts will be drilled and tapped.

To fasten the gearbox casting to the working table of the mill, an adapter plate has to be machined. See the drawing below for details. Accuracy is not really important, the only thing to observe is that the two surfaces are smooth and parallel to each other and that the plate can be securely fixed to the table. The twelve holes for the mounting studs where originally the engine power head attaches, will be used to fasten the adapter plate to the gearbox casting. The plate has to be thicker than the length of these studs and the holes have to be recessed to leave round about 20mm of the small diameter. For machining, not all of the bolts need to be equipped with nuts, four to six should suffice.

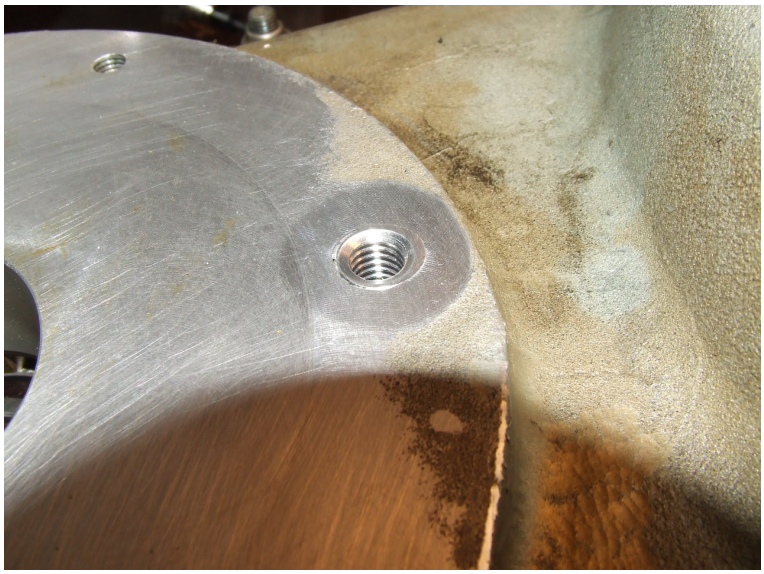




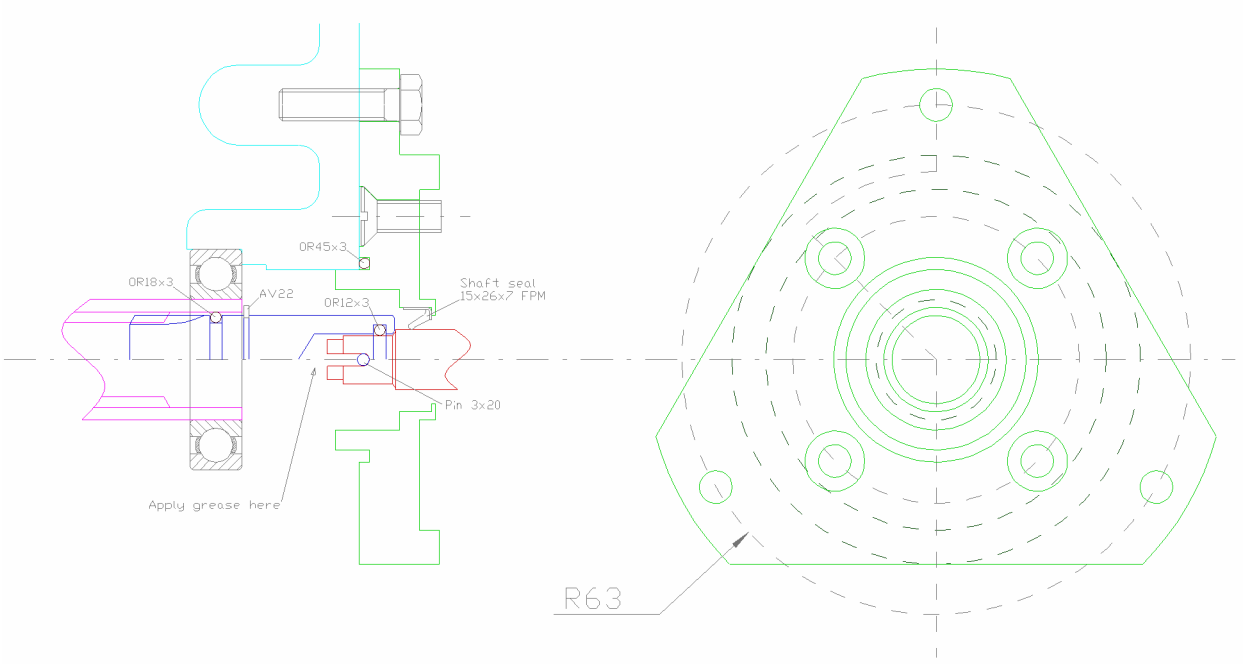
After the casting is fastened to the working table, make sure that the split surface is perpendicular to the machining spindle better than ± 0.05mm. Now use a “centricator” to accurately (± 0.01mm) align the milling spindle concentric to the bearing seat surface (red arrow in the photo to the left). Lock the working table in X- and Y-direction so it cannot move within the slide play. Recheck accuracy of the alignment. Use drills to machine the bore close to the required 45mm (say 40...43mm). Now use a spindle tool (adjustable rotating cutter) to machine the hole to its final size of 45 -0 + 0.02mm (blue arrow). You may use the alternator adapter flange (from below) to test the size of the bore.

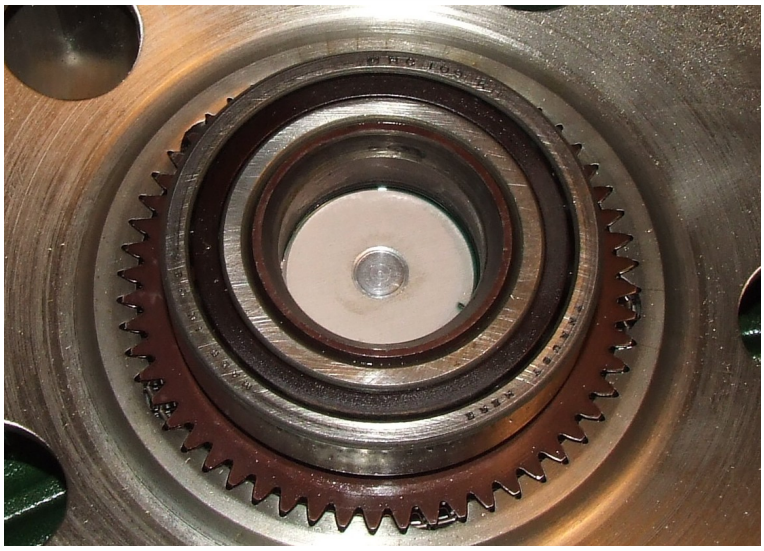


Once this is done, remove the adapter plate from the casting and clamp it with the split flange down onto the working table of your mill. Machine a smooth surface where the alternator will be attached to. The ignition exciter mounting holes have thread inserts and it may be somewhat awkward to cut through them. So be careful when you reach them. Remove only as much material to leave an evenly machined, smooth surface. The mounting holes have to be drilled 120° apart around the central bore at a radius of 63mm. You can also use the alternator flange to indicate the positions of these holes. Orient the holes so they will directly located in the center of the cast bosses inside the gearbox (that's a little bit awkward). The other awkward detail is that one of the new holes will interfere with a hole that accepted the ignition exciter mounting bolts. You may have to machine this hole bigger, produce a threaded insert and “Loctite” (648) it in place before you finally drill and tap the holes for the alternator (don't go deeper than 30mm with the drill). We use to tap metric M8x1.25, others may be more inclined to use 5/16” - 24 UNF imperial thread.



After that, the modification is complete. All that's left is a good cleanup of all the components of swarf and and other debris that may have accumulated inside the gearbox. Make sure that the sealing surfaces are free of remains form the old gasket. Remove and replace (or clean) the oil filter. Replace the gearbox gasket unless the old one is still in really good shape. You can use the modified gearbox casting to transfer the shape of the sealing surface to a sheet of gasket paper (0.5mm thickness) and cut it out. I've got a “scrap” gearbox that I use as a template to punch out the holes and cut around with a (very!) sharp cutter to make replacement gaskets. If you are careful, this is also possible with a gearbox casting that's still going to be used. Take special care when doing the “nose” of the oil transfer port. Make sure nothing stays in these passages. Before assembly, clean all bearings with white spirit or brake cleaner and pre-lubricate them with turbine oil. Don't use grease here! Don't use any sealant on single-piece gearbox gaskets. If you've got a split gasket, use only minor amounts of sealant (Hylomar or





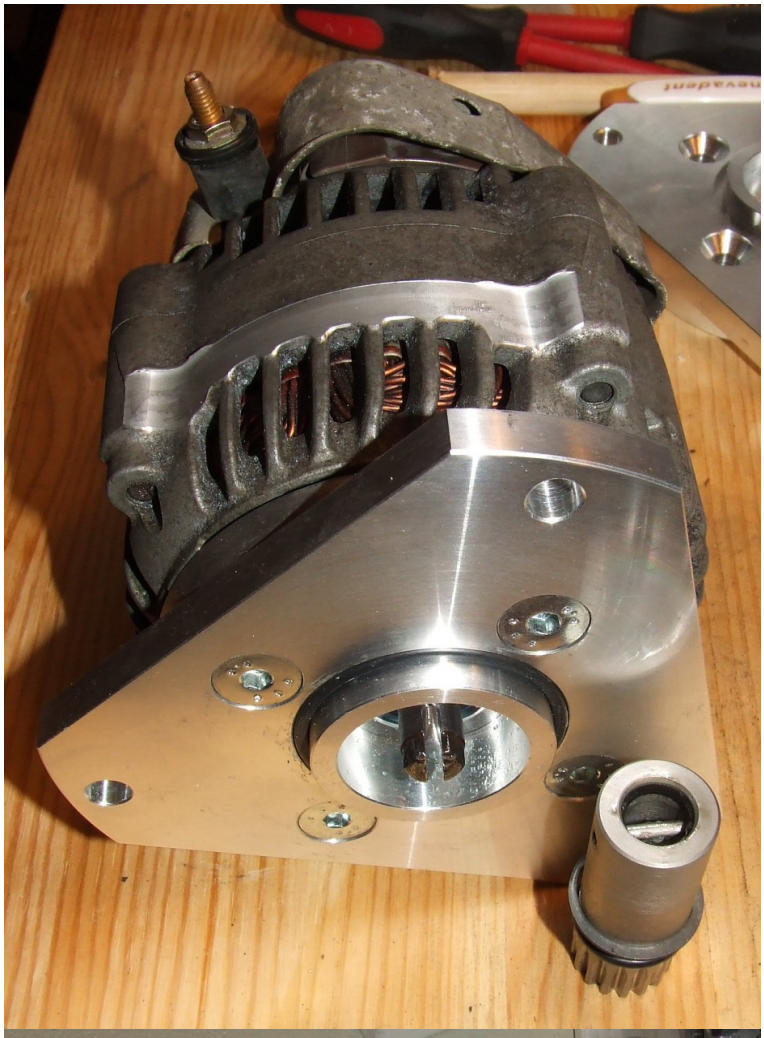
similar) in the split areas. Now may be a good time to check the shaft seals on the drive side of the gearbox. If anything shows traces of more than a little wear or is obviously damaged, replace it. When everything's clean, mate the gearbox halves and insert three bolts, one of them close to each of the alignment pins. Carefully and evenly tighten the bolts and make sure that all the alignment pins slide in place. If there is more than moderate friction, stop tightening the nuts and find the reason. A bearing may have come in skew and prevent further movement.

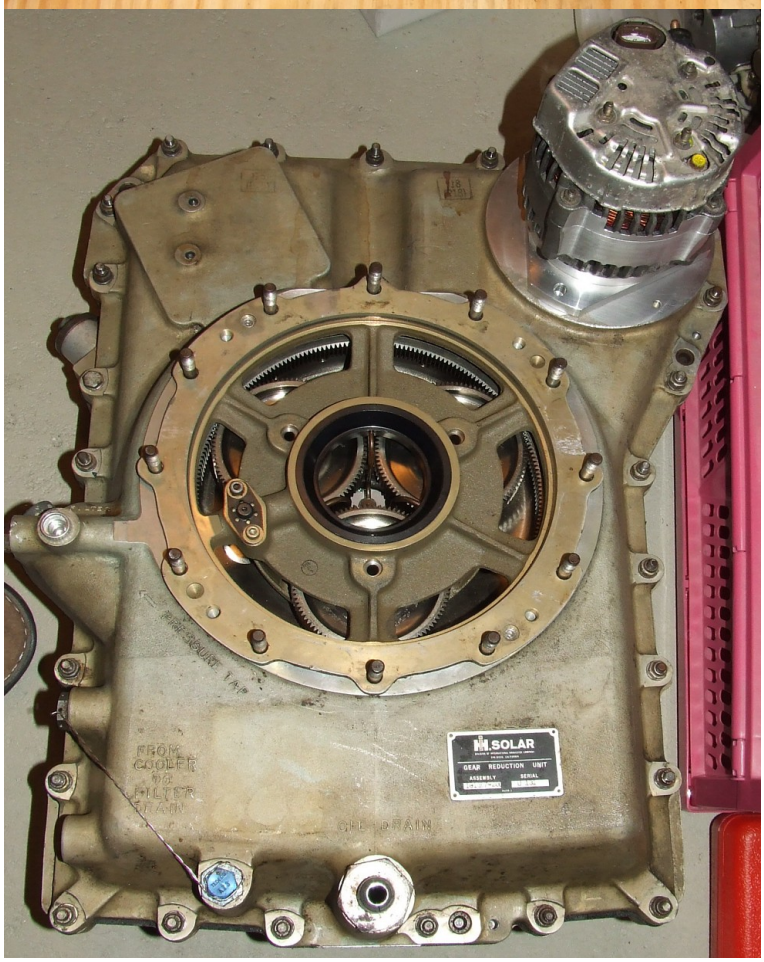
Before you put the hollow/ring gear assembly back into the gearbox, please check that the plug that seals the driveshaft from the exterior is rigidly in place. I found on several engines these plugs to have loosened and later touched the central oil injection nozzle from the rear (see worn area in the center of the plug in the above photo). This is not a serious problem but of course introduces aluminum filings into the gearbox cavity and allows for oil leakage through the output shaft. If you find something like this or just the plug to be loose, push it out completely, thoroughly degrease both the plug and the seating area (use ample amounts of acetone / brake cleaner). Then use Loctite 648 or another high-strength / high temperature compound to lock the plug back in place. Continue assembly only after the adhesive has cured.

Now insert all the other bolts that hold the gearbox together and gradually tighten them. Finally have a go with a torque wrench and torque tighten them to the specified torque (60 lb-in / 7Nm).

Before you reinstall the planetary gear spider, make sure that all the oil passages and nozzles are free of obstructions. This is easily done with a spray can of WD40 with the spray tube sealed against the oil feed orifice in the “thick” spoke. You should find even jets of liquid from the three orifices in the transfer tubes (to lubricate the planetary gears) and from the central oil injection nozzle. If you find any obstructions, unevenness or “twisted” jets, clean thoroughly with brake cleaner or with soft, mechanical means until the injection pattern is satisfactorily. Now is a good opportunity to install the “last chance filter” in the feed bore of the spider, see the related PDF.

After this is done, put the large O-ring back into the groove of the spider. If necessary, use stiff, sticky grease to keep it there during insertion of the spider. Align the oil transfer bore in the spider with the one in the gearbox and slide the spider over the studs. Put on three nuts (preferably no locknuts) and bushings or washers as not to damage the spider flange surface. Evenly tighten the nuts to pull the spider in. It may be





necessary to guide the O-ring into its groove with a slim wooden stencil (i.e. toothpick) just before the spider slides fully home. Once the spider is in, remove the nuts and bushings/washers again and proceed the same way with the turbine head and its O-ring seal. Now it's best to use the nuts behind the struts to pull the power head home. Once again, take care not to squeeze the O-ring.

After that, attach the accessories back to the engine. Since the alternator will be located where the ignition exciter was before, a mounting bracket for the latter will have to be fabricated from sheet metal. It is recommendable to use two of the nuts/ bolts that hold the gearbox together to fix the bracket to the engine. If the bracket is arranged as a right angle towards the rear, the length of the ignitor cable will be more than sufficient. After the plumbing is complete and the wiring harness is back in place, bolt the alternator to its pad. Inside its adapter flange there's an O-ring seal and a rotating shaft seal that prevents oil leakage from that area.

The nippon denso alternator that we use for this application will charge the battery at a maximum of 80 Amps. The charge voltage is 14.6V. The advantage of the particular model is the ability to disconnect the field coil via the control interface. This means, since the alternator doesn't directly supply its field, even in case of a defective regulator, a runaway situation can be terminated by just switching off the field. On the other hand, a sophisticated engine control system (my ECU system for instance) can control this safety function as well as momentarily disable the alternator in situations with excessive EGT when the power demand by the aircraft is high, maybe making available another two horsepowers (not that much but it may be just the little bit required to get out of a difficult situation...).

The photo to the left shows a gearbox with the alternator in place.

Splined shaft adapters, mounting flange adapters and modified alternators are available upon request. We can also modify the gearboxes but due to shipping expenses and customs fees, this is only reasonable if the owner is located within Europe. For more information on that modification please contact:

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