

GARP Part 2, the Great Axle Reconstruction Project

Intro

In [Part 1](#), I described the events leading to disassembly and repair of the front axle.

Part 2 describes the reassembly process.

Hubs and Spindles

Following on from [Part 1](#) which was initiated by a front end vibration, I have now cleaned up the spindles, removed the diff inner oil seals and checked the bearings for fit on the reground spindles. The shells are a tight fit, or rather, they need accuracy in location or they will jam sideways. Once correctly located the bearings slide and rotate very smoothly. Of course, once the bearings are tightened up the shells shouldn't move or rotate on the spindles anyway.

I removed the rear hub oil seals, using an inside gear puller pressing on a steel bar placed across the hub, but before replacing them, I tried the hubs and bearings on the reground spindles, temporarily reattached to the steering knuckles. This is to ensure they can be correctly assembled without jamming when the hub is offered up to the spindles. Had the inner bearing jammed on the spindle, it would have damaged the new oil seal when the hub was removed.

If the bearings are jamming, smoothing the spindle with some fine emery cloth and careful cleaning with WD40 will help, as will a smear of oil on the bearing surfaces. Older bearings will fit slightly easier than brand new ones.

If the hub and bearings can be successfully located on the spindle without jamming, a new oil seal can be pressed into the rear of the hub, by gently tapping around the edge with a heavy hammer until it's flush with the hub casing. Don't knock dirt from the back of the hub into the bearings.



Oil seal inserted into the rear of the hub.

Diff Carrier Rebuilding

Refer to Section 4 of the Dana 70 Maintenance Manual (available [here](#)) and the Carrier section of the Dana 60 Maintenance Manual (available [here](#)) for advice on how to do this. The front axle of an Oka is actually a Dana 60 while the rear is a Dana 70, but there are many similarities and the techniques in these manuals are relevant to both types. In fact there's a host of useful documents available from the Dana website [here](#).

After removing the diff centre carrier, I unbolted and removed the ring gear, knocked the roll pin through and removed the cross shaft and differential gears.

Because it's a heavy item and would be seriously damaged if it fell on the concrete floor, I inserted a sturdy cable through the carrier and tied it to a roof beam so that if it slipped out of the vice whilst being worked on, it would swing clear and only hit me, not the hard

concrete.

Removing the ring bolts was easier than anticipated since they should have been torqued to 130 ft-lbs (176 Nm) and Loctited too. I left four of the bolts partly in place and tapped them with a hammer to free up the ring gear, which wasn't very tight anyway. I moved the carrier from the vice to the workbench and then removed the last 4 bolts whilst holding the ring away from any hard objects. I didn't want to have to replace that as well, since ring gears only come as matched pairs with the pinion, which would have made it a much more difficult (and expensive) job.



The Ring Gear being removed.

The bearing cups came away when removing the diff centre, so I put old socks over each of the bearings to protect them while this work was being done.

I tapped out the roll pin using a length of 5mm steel rod, and the cross shaft then slid out of the carrier.

Removing the differential gears looked difficult since they remained

meshed together, but by turning a side gear, the spider gears simply walked themselves around to the opening in the diff and fell out. All 4 gears are seated on thrust washers which might be stuck to the carrier by oily suction.

I smoothed the rusted and pitted surfaces of the ring gear with fine emery paper and WD40 and cleaned them off with Brake Cleaner fluid.

The broken gear wheel will end up in my *Museum of Broken Car Parts* which is becoming quite extensive.



The diff in pieces ready for reassembly.



The Differential Gear Set.



A close up of the offending tooth.

Diff Oil Seals

Removal of the Inner Seals

To remove the inner diff oil seals I built a pusher rod made of a metre of 12mm tapped rod with a large steel washer, just the diameter of the rear guide section of the seal, bolted to the other end. A few whacks with a heavy hammer and the seals popped out into the diff chamber. Other people have used a large socket and several extension bars to achieve the same result, but I didn't have the right size socket (or sufficient extension bars). The bar needs to be at least 1 metre long to remove the LHS seal.

This bar, with a sock tied over the washer, also makes a useful tool for cleaning out the oily/muddy sludge from the axle tubes.



The pusher for removing the inner seals and cleaning out the axle tubes.

Installing the Inner Seals

To insert the seals I used a modified 40 mm high pressure water

fitting, which just fits inside the seal body, to avoid damaging the plastic parts of the seal with a hammer. The fitting will need to be cut down to about 50 mm long to allow a hammer to be swung inside the diff housing. I drilled and fitted a long bolt to the side of the plastic fitting as a handle, to keep my thumbs well clear of the hammer. A suitable socket might also work. Alternatively a pusher tool could be made up as described in the Dana 60 manual. Any rust or corrosion around the seal location should first be removed and the surfaces smoothed down.

The old seals had silicon gasket sealant smeared around their outer surfaces before insertion, presumably to keep water away from the metal surfaces and prevent premature rusting. Seems like a good idea, as does greasing the seals and guide inner surfaces to help the splined drive shafts find their location.

However, sealant on the seal casing also makes them slippery and more difficult to keep centred as they are inserted. It takes a quite a lot of effort in a confined space to insert the seals straight, since they are a tight fit, and I had to remove and reinsert one of them a couple of times to avoid fitting it crookedly. A pusher tool would certainly be more effective.

Mind the pinion gear, bearing seats and thumbs as you are wielding the hammer, damage to those would be expensive and/or painful.

Clean out all the resulting muck from the diff housing.



A modified 40 mm high pressure water fitting would fit inside the body of the seal.

Reassembling the Diff Carrier

Before reassembling the diff centre, ensure that the ring bolts and tapped holes in the ring gear are thoroughly cleaned and free of old Loctite.

Before the ring is refitted, the new gear set must be installed, with their thrust washers, and the cross shaft and roll pin inserted. Oil all the parts well before assembly and check for smooth rotation.

Installing the Differential Gears

You'll need about 15 fingers to hold the 4 gears and their thrust washers in the right place but it's not too difficult. Insert the side gears first on their washers, with the carrier horizontal so they can't fall out. Then insert both spider gears exactly 180° apart from either side of the carrier and walk them into the carrier case by turning both side gears in the same direction. If they are not exactly 180° apart on the side gears the cross shaft holes won't line up. I found it easier to

slide the saucer shaped thrust washers in behind the spider gears *after* the gears were in place.



Gears reinstalled in the carrier.

Once all the gears are in place, centre the the spider gear washers with a finger and insert the cross shaft with the roll pin holes roughly in line. Use a thin bar to turn the cross shaft until the roll pin holes line up and drive in the roll pin. The differential gears are now complete, assuming they all turn smoothly.



Driving the Roll Pin home to complete the assembly.

Installing the Ring Gear

The ring gear should be replaced in its original orientation (not sure why, it doesn't seem to be a balanced item, but that's what the manual says) and this can be determined from the imprint markings on the carrier made by the ring. There is a cut out on one side of the ring, presumably for oil flow, which will show up as a shadow on the carrier. I also took photos of the stamped markings to confirm it's location.

The manual also suggests replacing the 12 ring gear bolts, but they are very high tensile bolts (SAE Grade 8, equivalent to metric class 10.9) and if they are in good condition and not stretched or worn, the originals could be reused. On a rear diff, which is subject to a far higher and continuous load, I would certainly replace the bolts.

[BTW, if you are excited by such things, there is a very good Australian document on bolts (and fasteners in general) available for download from the James Glen Company [here](#), or view an on-line version [here](#)].

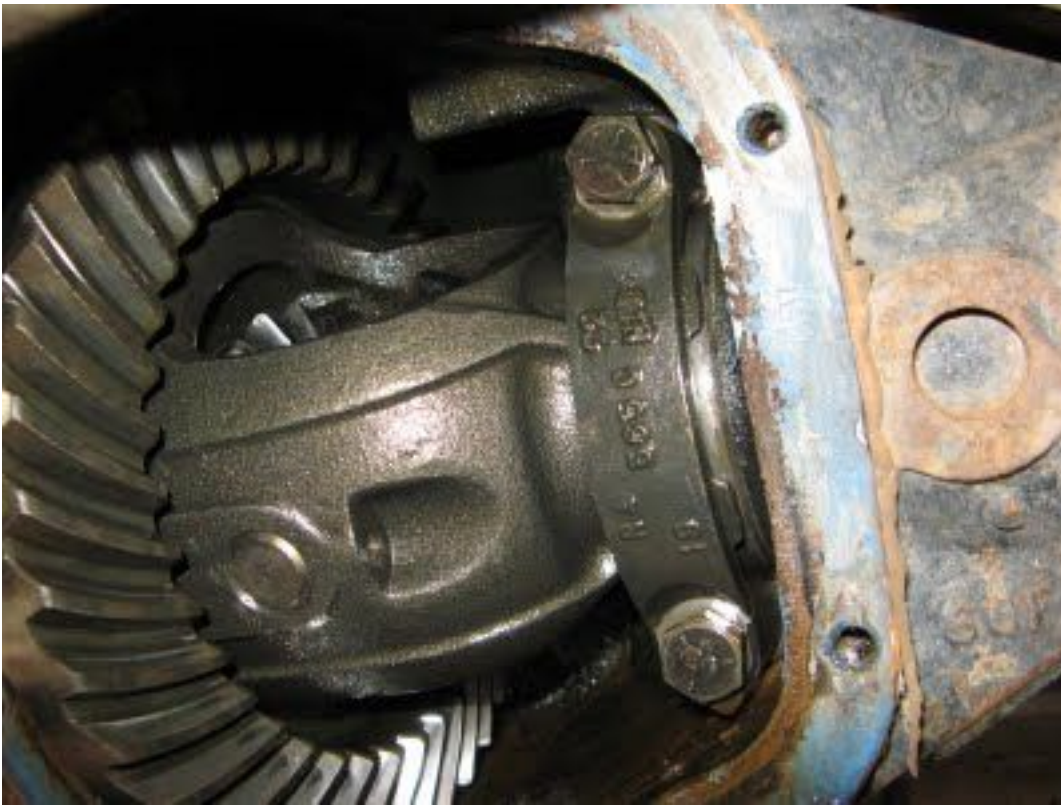
The ring bolts need to be tightened alternately to 130 ft-lbs (176 Nm) and Loctited. A tight fitting socket is required (hex, not multi-point is preferred to avoid rounding the corners) and the carrier needs to be securely held in a large vice, preferably tied to something substantial to catch it if it breaks loose. Vice jaws have been known to snap off. Protect the exposed bearings while doing this.

My torque wrench only goes up to 110 ft-lbs so I tightened the bolts alternately to 110 ft-lbs and then used a longer bar to turn them all a fraction of a turn more, about 25° to 30° (1/12th of a turn max.). I reasoned that this would increase the torque to around 130 ft-lbs. Don't forget the Loctite and ensure you haven't missed out tightening any bolts, 12 is a lot to remember.

Reinstalling the Diff Carrier

Fully fitted with gears, the carrier is a bit of a handful to manage under the vehicle. It has to be manoeuvred around the tie rod, the bearing cups have to be fitted and held in place and the whole assembly inserted straight and level into the housing so that the pinion engages with the ring gear and the bearing cups locate correctly in their slots. And it's heavy and makes your arms ache.

The bearing cups had previously been rotating in their housing and caused a burn mark so I applied some Loctite 641 (bearing retaining compound) to the housing and bearing caps to stop them rotating.



The differential installed in the carrier.

It took me a couple of goes before I could locate the carrier properly, but I had the bolts and bearing caps ready to go so that when finally it slipped into place I could whip in a bolt to hold it there before it all fell out again. Had the diff carrier been a press fit requiring a diff spreader to remove it, I doubt that it could have been replaced in situ and the axle would have had to be removed first.

Once I had recovered my strength and confirmed that the gears all rotated correctly, I Loctited the bearing cap bolts and torqued them up to 80 ft-lbs. The bearing caps should be replaced in the same orientation as previously. They have stamped markings on to aid identification.

Fitting the Drive Shafts

Once the diff is in and working correctly (although I don't see how it couldn't work as it's a very simple but clever mechanism), the drive shafts can be installed.

I had already cleaned them up, checked the UJ's and replaced the oil

seals. I was surprised to find the short shaft UJ had a grease nipple, which worked. It must have been hidden under years of dirt and sludge and in 5 years I had never noticed it. Presumably this UJ, or maybe the complete shaft, had been replaced at some stage as the inner splines were also much less worn than the long shaft, which had no grease nipple. Fortunately there was little play in either UJ.

When reinstalling the drive shafts I wanted to avoid the splined end from collecting dirt, as it was pushed along the axle tube, and injecting it into the diff housing. So I placed a thin plastic strip in the axle tube and slid the drive shaft along that and straight into the diff. The plastic strip was actually the cap from a length of Clipsal rectangular electrical conduit and acted like a thin "V" shape for the splined shaft to slide along. When the shaft had entered the diff housing but not fully engaged with the side gear, I pulled the plastic strip out of the axle tube and pushed the drive shaft home, all nice and clean.



Using a length of plastic strip to keep the drive shaft out of the dirt. The oil seal has also been replaced.

Refitting the Spindle

Before refitting the spindles, I levered out the old oil seals (which had broken in 2 anyway), flushed out and re-greased the needle bearings and tapped new oil seals into the back of the spindles.

Clean and grease the rear of the spindles around the needle bearing seal since the drive shaft oil seal engages that surface.



Needle bearings greased and new oil seal fitted into spindle.

Strangely, I couldn't recall the order in which the spindle, brake calliper plate and stone guard came off, so I thought "simple, I'll look it up in the manual".

Wrong. There are pictures of the axle, spindle and hub arrangements and pictures of the brake rotor and calliper, but none showing both. Eventually I deduced that the spindle is attached direct to the steering knuckle with the brake calliper plate on next and the stone guard on last. It didn't look right, due to the cranked angle of the calliper plate and stone guard, but it was logical when I thought about it.

Loctite the spindle fixing nuts and tighten them to 65 ft-lbs. Once the hub is in place you can't reach them anymore.



Refitting the Spindle, drivers side.

Grease the rear oil seal bearing surface and clean out the spindle nut threads.

When fitting the hub to the spindle, have the greased up outer bearing and the hex spindle nut ready to go. Otherwise, when you fit the hub with only the rear bearing in place the hub might slip down the spindle when you let go.

I was tempted to put bearing retaining compound on the bearing cup surfaces to prevent the original problem of the bearing cups rotating on the spindles, but there is so much grease around that I doubt that the retaining compound could do its job effectively. With rebuilt and reground spindles it shouldn't be necessary anyway.

The spindle nuts should be tightened to 50 ft-lbs, spun a few times to seat the bearings and circulate the grease and then backed off about

45° before fitting the lock washer and outer lock nut. Pre-loading is essential for tapered roller bearings so they share the load equally. If there is any free movement, they are too loose. On the road I check the temperature of the hubs frequently to ensure they are not getting too hot. Warm is OK due to the brake heat, but if one is appreciably hotter than the others, something is wrong.

[There are some very useful tech notes on bearing problems and installation at the Timken site [here](#) and [here](#)].

Fitting the lock washers can be a tricky task. Bend 2 tabs in towards the bearing, being careful not to go too far or you can damage the bearing cage. I used a rod formed from the tapered end cut off a tent peg to do this. Bending 2 tabs outwards on to the lock nut is even more difficult. I made a small tool using another tent pen with a sharp bend on one end (more than 90° so it won't slip off) and threaded the other end. Using a breaker bar with a hole in it, I slid the tool in behind the tabs and levered against a nut fitted on the threaded end. Once the tab has bent slightly, I used a square shank screwdriver to lever them flat by twisting it with a wrench on the shank.

[In the US, there are more sophisticated (but expensive) locking devices described [here](#) and [here](#)].

Epilogue

The rest of the rebuilding process (free wheeling hubs, tie rod ends, steering damper, brakes, wheels, diff cover/oil etc.) should be fairly straight forward, but as with any major project, check if there are any bits left over and check that everything is reconnected, tightened, greased or refilled.

On it's first test run, there was no evidence of the original vibration which kicked off the whole axle reconstruction program in the first place, and the steering seemed a lot smoother, although there's no logical reason for that other than the greased joints. I ran the Oka in

4wd for a while, but with the hubs unlocked, to allow oil to circulate through the diff components before any load is applied to it.

This has been quite a long and complex rebuilding process and ironically, there will be almost nothing to show for it at the end, except peace of mind.

However, it is not difficult or mechanically challenging or even very expensive, there's just a lot of it.