

## Vibrations from the Front Axle - GARP, The Great Axle Reconstruction Project

### Part 1 Repairing the Spindles

Over the past few months our Oka developed an occasional but worrying vibration at 60-70 km/h from what appears to be the front axle/wheel area, possibly from the passengers side. Braking or turning or de-clutching didn't seem to affect it and it was there in 4wd and 2wd.

At first I thought it was just knobbly tyres on a rough road surface (that's what it sounds like), or the brake callipers (see [this article](#), which is relevant to Oka brakes), but I thought I had fixed any calliper/pad rattles and looseness. Then I thought maybe a wheel bearing shell might be jamming occasionally and rotating on the spindle, but why only at one speed? Investigating that possibility is a rotten job, with freewheeling hubs and brake callipers to remove, lock washers, messy grease etc. and anyway I had checked/greased the bearings last year and recently had the wheels balanced.

"Tim" on the Oka Owners Group website suggested that the vibration might be caused by a worn steering damper. I haven't investigated that yet, since everything is now in pieces, but it is a possibility, although I don't quite understand how it could occur or why turning the steering wheel didn't affect it. I had considered ignoring the problem completely and just turning up the radio, but after checking the steering rods and swivels, springs and shockers, and any part of the bodywork which could have been vibrating in the wind, I bit the bullet and took the wheel hub assembly to pieces.



*Pic 1. The groove and ridge ringed on the spindle shaft. (Click to enlarge)*

It only took an hour or so to get to the heart of the problem, the outer bearing shell had indeed been rotating on the spindle and worn a groove (about 0.5 mm deep), so that the bearing was a fairly loose fit on the shaft. A ridge had also developed which prevented it from sliding freely, and this would affect the bearing pre-load adjustment as well. See ringed area on Pic 1.

What to do about it was the next question. If we were in the US, a replacement spindle for a Dana 60 axle would be easy to find (and cost around \$US100-150), but in Oz, from Oka the price was out of this world (\$600, each).

So I investigated a repair process. I found a company in Adelaide (Adelaide Grinding) that would deposit a coating of metal on the shaft (by replating or metal spraying) and then regrind the bearing surfaces to their original dimensions. Since I wanted to do this only once, I also had the inner bearing surface treated at the same time, even though it wasn't as badly worn. Even better, the total cost was less than a quarter of the new spindle price.

While I was at it, I took the other spindle off and, not surprisingly, it was in a similar state of disrepair so I had that repaired as well.



*Pic 2. The repaired spindle. Bearings are a good tight slide fit on the reground shafts.*

I will also replace the oil seals at the rear of the spindles and the seals on the drive shafts to keep water out of the bearings. The needle roller bearings which centre the drive shaft were very gunged up but not badly worn, so a good clean out and regrease is all that is necessary.

The 6 nuts holding the brake calliper and spindle on to the steering knuckle weren't as tight as I was expecting, considering that they support the whole weight of the vehicle, plus traction and braking loads as well, so I will Loctite them and torque them to 60 to 70 ft-lbs. The torque setting for Dana 60 Spindle nuts is 65 ft-lbs (88 Nm) and I assume it would be the same for Dana 70 rear axles.



I did consider rotating the spindles so that the previously worn section was now having a rest and a new section could take up the load. However, that plan came to nought when I discovered that the spindle bolt holes are not symmetrical and the spindle will only fit one-way. It is possible to interchange the left and right side spindles however, which might have a marginal benefit.

### The Low Point Approaches...

While the hubs were off being repaired, I took the opportunity to change the front diff oil.

So I loosened the diff cover bolts to let the oil out (for there are no drain plugs on these axles) and heard a "clink" as something dropped into the tray. Rather than dirty my fingers, I got my magnetic wand out and stirred it around in the dirty oil. When I removed it there was part of a gear tooth attached to the end.

My heart sank as I knew what that would mean, and sure enough, when I removed the cover and turned the inner gears around there was one with part of its tooth missing.



*Pic 3. Toothache in the differential.*

Had there been a drain plug I would never have noticed the missing tooth, but since I now

knew about it, it simply couldn't be ignored. From a pragmatic perspective, there would never be a better opportunity to repair the diff, as removing it was only 4 bolts away, since the hubs, wheels, brakes and drive shafts had already been removed.

This was also the unexpected opportunity I had been waiting for to replace the inner axle oil seals which are only accessible when the diff is removed. Muddy water from Kimberley creek crossings had got into the diff housing past the worn seals and laid at the bottom of the housing. This had caused surface rusting and pitting on some of the crown wheel teeth and bolts, since the front diff is stationary for much of the time.

Mine site seals are available to block off the openings to the axles tubes, but the advice I received is that they tend to trap water in the tubes leading to worse corrosion problems, and it's better to allow them to drain open to the atmosphere.

Removing the diff was surprisingly easy and after freeing the 4 bearing cap bolts, it just about fell out, or would have done, except for the steering tie rod which crosses right in front of the diff cover. This tie rod can't be easily removed since it hits the bottom of the springs before the tie rod ends can be lifted free from the steering knuckles. Luckily, after a bit of manoeuvring I managed to turn the diff carrier assembly on its side and slide it out under the tie rod. If you've already loosened one or both tie rod ends, it would probably help to clamp the rod up as high as possible to keep it out of the way. I just hope putting it back will be as easy.

So, buoyed with the negligible enthusiasm which stems from having reluctantly removed the diff, I went on the hunt for replacement gears, and once again in the US they are easy to come by, but not so easy in Oz. They are available from a few auto parts companies specialising in American vehicles, (eg [here](#) and [here](#)) but to be sure I got Oka compatible components, I acquired a second hand set from Paul Nott at [East Coast Oka](#) in Melbourne (which turned out to be a lot less worn than my original set). With some replacement oil seals on the way from Oka in Perth I am now able to start GARP, the *Great Axle Reconstruction Project*.

Don't you just love it when the manuals say "To reassemble, simply reverse the disassembly procedure"?

Part 2, 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.



Differential Gear Set.

The





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  $180^\circ$  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  $180^\circ$  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 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 it's 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.