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Fitting an ARB diff locker

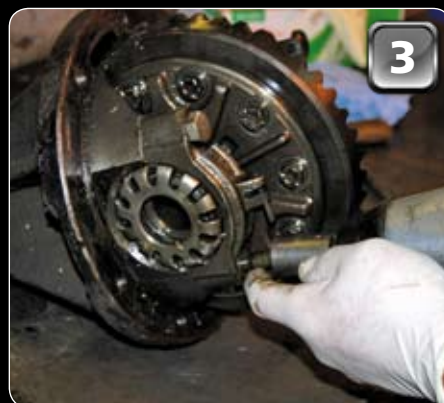
When Trevor Cuthbertson from LRM magazine wanted to get better traction for his Land Rover, he came to Devon 4x4 for the fitment of the famous ARB air-locking differential.

These articles, first published in LRM Oct / Nov 2008 show the step-by-step process of installation.

Notes :

Since the production of this article in the summer, Land Rover have made recommendation that the crownwheel bolts are replaced whenever the differential assembly is dismantled. This is now standard practice in the Devon 4x4 workshops.

The locker shown in the article is an RD56, 24 spline Land Rover fitment. This has now been superseded to the newer RD128 model. Fitting procedures are very similar except that on the RD128 models it may be necessary to machine the opposite bearing cap to the one shown in the article to allow proper adjustment. The routing of the airline from the seal housing inside the differential is also slightly different.



EXPERT AIR LOCKING

Trevor's 90 will be able to get into and out of just about anything once the ARB differentials are in place

DRIVING ONE'S Land Rover across arduous terrain can lead to some of the most amazing adventures and fun that can be imagined. Losing traction and spinning your wheels can abruptly end the adventure, leaving you stranded, frustrated and often embarrassed at the most inappropriate time.

The problem is that the factory-fitted open differentials in your Land Rover's axles are directing all of the engine's power to the spinning wheel(s) and not to the ones that still have traction. So you go nowhere fast, often spraying up a dramatic but useless mess of mud everywhere.

There are a number of solutions to this

problem. A limited slip differential may offer some improvement over a standard diff; but often the amount of power directed to the non-spinning wheel is not sufficient.

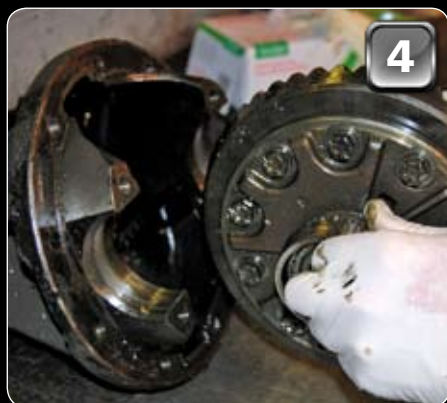
Automatic fully locking differentials can be very effective. However, they can be noisy when disengaging and can upset the on-road driving characteristics of the Land Rover – I know this to my cost when I could not steer through a swerve on an icy road and ended up nose down in a ditch, one snowy Boxing Day.

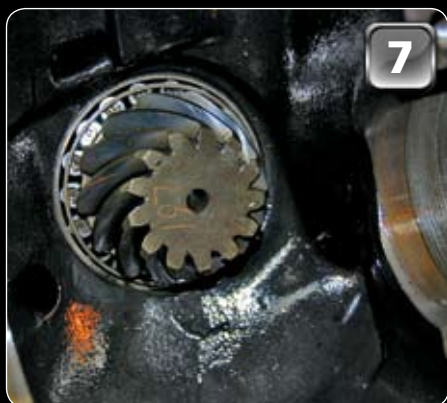
The solution, which is the preferred option of many of the serious off-roaders and challenge competitors, is the air-locking differential – created to provide

100 percent traction to all wheels on demand. Air lockers employ compressed air from a 12v compressor to activate (and deactivate) a solid and durable locking mechanism inside the diff at the flick of a switch.

Over the next two months I'll show how Devon 4x4 fitted ARB air locking differentials in place of the standard diffs for my Defender 90. The axles used in the build have a 24-spline differential in the front and a late Td5 110 axle in the rear (with the P38 type differential).

Devon 4x4 – a very well-known company in the Land Rover field – offer a complete range of services for owners and enthusiasts of all makes of 4x4





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and off-road vehicles. Martin Kingdon is Devon 4x4's workshop manager and has fitted in excess of 200 pairs of ARB differentials in his ten years with the company. So my differentials are in the safest possible pair of expert hands.

Picture 1 The components of the ARB air locking kit are laid out on the spotlessly clean Devon 4x4 workbench. Everything is checked ready for the installation into the Land Rover differential.

Picture 2 Martin sets my front differential assembly on the workbench and carefully checks that everything is serviceable and up to the job. Particular attention is paid to the pinion and bearing teeth as these will be retained in the new air locking differential installation.

Picture 3 The bearing caps are each marked with a punch to enable Martin to replace them back on the correct side on



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re-assembly, then the end cap bolts are removed.

Picture 4 The end caps are removed and the crown wheel with the original open differential are carefully removed. The original side bearings are discarded at this stage, even if in good condition. Martin points out that Devon 4x4 will not skimp on a £500 ARB air locker installation for the sake of £11 worth of new bearings.

Picture 5 The bolts holding the original diff to the crown wheel are removed so that the two components can be separated.

Picture 6 The crown wheel is set on the bench after separation and very carefully cleaned. If any dirt or grime remains on the face of the crown wheel, it will be impossible to set up the new locking differential correctly, so it must

be spotlessly clean. Note the number '197' engraved into the edge of the crown wheel...

Picture 7 ...this number matches the number on the pinion. The crown wheel and pinion are matched pairs – one cannot be replaced on its own; if there is wear on these components they must be replaced with another matching pair.

Picture 8 Martin gives the crown wheel a blast of compressed air to remove any remaining dust, dirt or moisture in readiness for the new locking differential.

Picture 9 The new ARB differential is set into position over the now clean crown wheel. The crown wheel is a very snug fit around the differential. Martin says that on some occasions the crown wheel needs to be warmed in a saucepan of hot water in order to expand it enough to fit the differential.

Picture 10 Martin takes two clean bolts to loosely attach the crown wheel to the differential. These two bolts do not yet have any thread lock compound applied – therefore Martin has marked them with a felt pen to identify them. Martin picked up this tip from someone who "learned the hard way", although he wouldn't elaborate!

Picture 11 The crown wheel must be tightened into place completely level or there is a risk of it jamming. Martin slowly and carefully tightens the bolts with a socket by hand until the crown wheel is tight against the differential.



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► **Picture 12** Each of the bolts are cleaned using a wire brush attachment on the bench grinder. This is to remove all traces of old loctite, grease and oil.

Picture 13 As soon as the bolts are clean, each of them has an application of loctite (thread lock compound) to ensure they never work loose inside the differential casing.

Picture 14 The bolts are tightened down using the air ratchet and socket for speed. The first two bolts (marked with felt pen) are removed to receive their coat of loctite and then re-inserted.

Picture 15 The bolts are then tightened with a torque wrench to the correct torque (60 Nm). The first bolt is tightened followed by

its diagonally opposite partner, and so on.

Picture 16 The crown wheel and differential assembly is now ready for new side bearings.

Picture 17 Using a 30-tonne hydraulic press, a new side bearing is pressed on to the differential. These bearings (similar to the pinion and crown wheel) are matched pairs – the bearing shell and inner bearing race must stay together. To keep the bearing sets matched, Martin has a method of putting one bearing shell in each pocket of his cover-alls, corresponding to each side of the differential – this way they never get mixed up.

Picture 18 A new outer bearing is also pressed on to the other side of the differential. On the crown wheel side of the differential, the original bearing adjuster nut is retained. However, a new bearing adjuster nut is supplied in the kit from ARB, for the pinion side of the differential.



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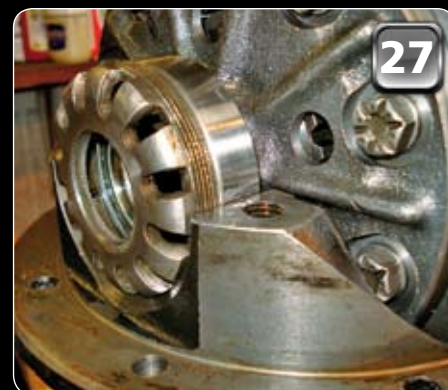
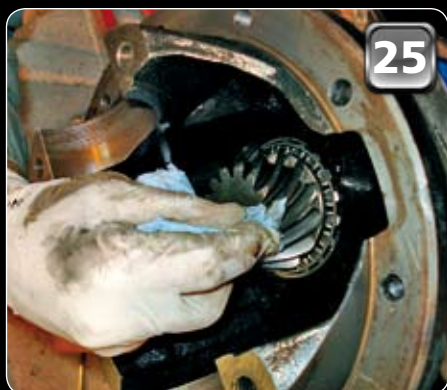
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Picture 19 Martin's attention now turns to the differential casing. A pilot hole is drilled through the very top of the casing – but well clear of where the fixing nut and axle casing stud will be located. To be sure to find the top of the differential casing, the flat side of the casing should be at the bottom.

Picture 20 After the pilot hole is drilled, a 7/16 inch hole is drilled into the casing. The differential casing is very thick and strong in this area, so a very sharp drill bit makes the job easier.

Picture 21 Martin now uses a one-quarter inch NPT tapered tap in the hole, creating a tapered thread in the differential casing. The tap shouldn't be turned too far into the hole, otherwise the hole will become too large for the bulkhead fitting.

Picture 22 The bulkhead fitting is tested in the tapered thread. If it screws about half way into the hole, this is about perfect.

Pictures 23 & 24 Now before the re-assembly of the differential to the casing takes place, all swarf, dirt, old RTV and debris is removed from the casing and the workbench. We don't want any foreign matter in our new bearings and diff.

Picture 25 Martin makes sure that the pinion teeth are spotless, otherwise false readings will be given when setting the diff up.

Picture 26 A coating of oil is applied to the outer bearing shell, then they're placed in position over the inner bearing race on the differential. The complete assembly is then offered up to the diff casing.

Picture 27 The bearing adjusters are placed in position, taking care to seat them correctly in their threads. The bearing cap is then bolted down on the crown wheel side of the differential.

Picture 28 The bearing cap on the pinion side has a roughness and unevenness

along its length. This doesn't matter for the standard differential. However, it is a very close fit to the ARB differential.

Picture 29 Martin uses a metal sanding disc to even-up the bearing cap and remove the roughness. This is followed by a finer grade to remove the burrs.

Picture 30 After careful machining by Martin the bearing cap fits clear of the ARB locking differential. A neat job!

■ Next month: Setting up the pre-load on the differential, routing the air-line through the casing and how the air compressor operates the locking diffs. **LRM**

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LOCKING IT ALL DOWN

With the 90 all ready to accept the new differentials, Devon 4x4 show us how to get them accurately set up

LAST MONTH we saw how Martin Kingdon – Devon 4x4's highly experienced workshop manager – painstakingly prepared the front differential casing, crown wheel and pinion from our Defender 90. He then fitted the new ARB air-locking differential to the crown wheel, pressed on new bearings and finally fitted the assembly to the casing.

Martin also modified the bearing cap to allow the bulkier ARB differential to fit properly and neatly into the casing. So far pretty

straightforward stuff – although Martin's attention to detail and meticulously clean working was an excellent lesson in how a professional approaches the job.

Now Martin demonstrates how his vast experience with ARB locking differentials will ensure that our ARB locking differentials will be properly adjusted and accurately set up. They will therefore give a lifetime of service in normal everyday driving and, crucially, will always be ready to be called instantly

into action when the going gets tough – by a simple flick of a switch to activate them.

Remember, Martin, along side Devon 4x4 proprietor Simon Buck, has built and prepared challenge vehicles which have competed in, and won, some of the toughest off-road competitions in the world.

Picture 1 The bearing caps have been tightened enough to hold everything in place so that any adjustments made will remain accurate. The adjusters are then tightened to the 'bite point', using a Devon 4x4 custom-made tool, then turned by one more segment.

Picture 2 A dial gauge is attached to the differential casing and the measuring





probe aligned to the crown wheel. This is used to measure the backlash – the relative movement between the crown wheel and pinion gears. The end cap adjusters effectively move the crown wheel closer to, or away from, the pinion gears – having the effect of reducing or increasing amount of movement or backlash.

Picture 3 Martin grips the differential flange firmly with a large pipe wrench so that the pinion gear remains fixed. Then, by attempting to move the crown wheel, the gauge measures the amount of backlash between the two gears. If there is excessive backlash – it's too loose – premature wear of the pinion and crown wheel and excessive noise would result. If the gears are too tight together the result will be overheating and excessive wear.

Picture 4 Martin had the backlash set correctly first time (but then he's set-up a few differentials in his time), with a reading

of between 0.1 to 0.17mm checked in four places around the crown wheel using the dial gauge. He then took the end cap bolts out, applied loctite and re-fitted them. They were then correctly tightened to 100 Nm using a torque wrench.

Picture 5 The ARB locking differential assembly is now ready for the air seal housing to be fitted. The factory grease is removed from the seal housing and compressed air is blown through the pipe to ensure that there is a clean air way.

Picture 6 The seal housing is then offered up to the differential.

Picture 7 The copper air pipe needs to be manipulated around the differential – it must not touch the moving components but also must be close enough so that the pipe does not foul the axle casing, when the finished assembly is re-fitted to the Land Rover axle.

Picture 8 Martin has carefully contoured the air pipe around the differential and through the threaded hole that we saw drilled in the casing last month.

Picture 9 Here we see the pipe emerging through the differential casing, having been carefully routed around the differential.

Picture 10 Martin marks the air pipe with a marker in the position where he wants to remove the excess pipe.

Picture 11 The seal housing with pipe are removed again so that Martin can cut off the excess pipe using a neat little pipe-cutter.

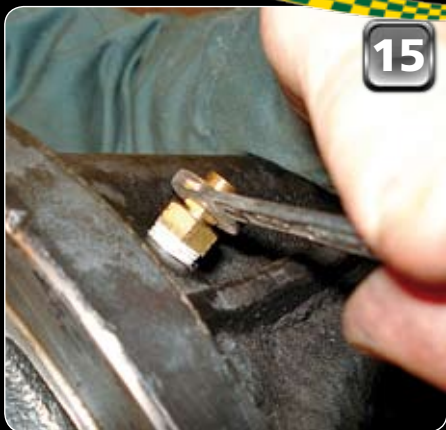
Picture 12 Several layers of PTFE sealing tape are applied to the bulkhead fitting by Martin...

Picture 13 ...and the fitting is tightened into the taper threaded hole in the differential casing.





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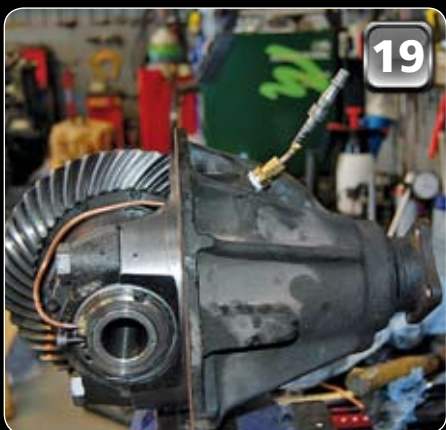
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Picture 14 With the air pipe route through the differential casing again, an O ring is fitted and the air connection union is screwed into place.

Picture 15 The union is tightened with a spanner to create an airtight seal. The air supply from the compressor in the Land Rover will be attached to this union after the differential is re-fitted to the axle.

Picture 16 The O rings have been fitted to the air seal housing and a spot of oil applied – “to give them a start in life”, says Martin – then the housing is clipped into position on the differential.

Picture 17 The finished air system installation.

Picture 18 The baring cap locking tabs have been re-fitted so that the adjuster can

never work loose inside the axle.

Picture 19 A temporary quick release workshop airline fitting is connected to the differential...

Picture 20 ...and a high pressure air line is attached. Martin listens for air leaks as he releases the air to operate the locking mechanism. Having opened and closed the locker several times, Martin declares that everything is working perfectly and the job on this front differential is complete.

Picture 21 The rear axle and differential in our Defender 90 is from a late Td5 110. This is known as the ‘Wolf’ or ‘P38’ type differential (depending whom one is talking to)! Essentially, what we have with this type of axle is a large and very strong differential in a small housing. Martin points out that

the ARB differential – Type 57 – for this axle is even larger than the Rover version.

Picture 22 Fitting an ARB locking differential to the late 110 axle is all very similar to the fitting of the ‘Rover’ type with a few important differences and challenges. Here we can see that the casing is indeed very compact – but drilling for the air line is more difficult. The casing is very thick and strong in the area that we want the air line to come through.

Picture 23 There are sections of this compact casing where metal needs to be removed in order for the big ARB locker to fit. Here Martin points to a section that he has marked for grinding.

Picture 24 The pinion is carefully covered to keep sparks and swarf out during the grinding operation.



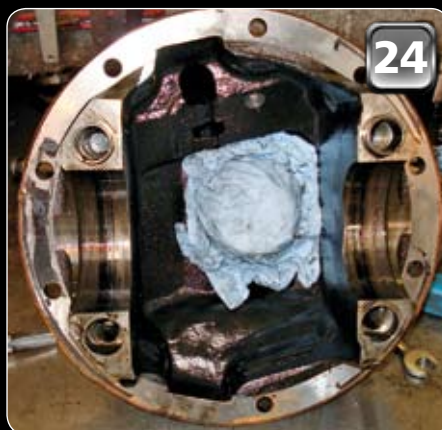
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Picture 25 Firstly, Martin uses a coarser grinding disc to remove excess material for the differential casing.

Picture 26 A finer sanding type disc is used to finish the job and leave a smooth inner surface in the casing.

Picture 27 Here we see the part of the modified casing. This type of grinding was required in two different locations to allow the ARB locking differential to fit into the casing.

Picture 28 When the ARB locker is fitted to the differential casing – in much the

same way as before – we can see how very tight the fit actually is. Martin has checked carefully all around the moving parts – although everything is very snug, nothing is fouling.

Picture 29 Both modified differentials are very carefully packaged-up for the journey home via Devon 4x4's professional delivery service.

Picture 30 This is the late Td5 110 type axle casing showing a neat network of piping. The blue line is the air supply to the ARB locking differential. The yellow line is the axle breather pipe and the brown/

copper lines are the brake pipes running to the rear brake callipers.

■ Many thanks to Simon and Liz Buck, Martin Kingdon and all the team at Devon 4x4 for a very helpful and informative visit to their workshops and the world of ARB air locking differentials.

LRM

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