Unwinding Unwound – Mike Phelan 6/2003

Unfortunately, some may say, it is necessary to explain a few things about the A-Series gearbox design. Whilst many of us have no compunction about stripping an engine down, some regard the gearbox as an impenetrable complexity of mysteries. It **isn't**.
In essence, the gearbox is a simpler device and easier to understand than an engine. Furthermore, that of the A-Series is a unique and brilliant design, largely unsung. You didn't expect anything less, though, did you?

The gearbox is actually a three-speed box with a fourth gear added **without** adding any extra gearwheels. Cool or what? Fourth is **not** an overdrive, though – it was called such to get round M Boulanger's insistence on only three speeds. As we said, this is a simple explanation, so we won't go into the minutiae of how the synchromesh operates or touch the final drive. Note that I will refer to gearwheels as 'pinions' to avoid confusion with 'gears' which are the ratios you select. They are not 'cogs' – cogs are found on old mangles and such; this is a piece of precision engineering.

From the clutch, power goes in via the *input shaft* (logical, huh?) which has one pinion on it. This wheel drives the *laygear* constantly. The laygear has another three pinions formed on it – one each for first, second and reverse. The reverse one gears constantly with a *reverse idler* to change the direction of rotation. At the top of the box is a *mainshaft* which is coaxial with the input shaft, but not connected to it in any way. On it slides, on splines, the villain of the piece, the *second and third synchro hub.* There is a *second gear pinion*, also, which gears with that on the laygear, but runs free on the mainshaft.

To engage second, the hub slides rearwards and locks the second gear pinion to the shaft. For third, it slides forward and locks the input shaft and mainshaft together. First and reverse are catered for by having a large sliding pinion on the outside of the hub that has straight teeth that slide into engagement with the reverse idler or first gear on the laygear.
The rear of the mainshaft has a pinion that takes the drive down via the pinion shaft to the final drive, which lives between the gearbox and clutch. This pinion shaft also is what the laygear happens to run on.

Fourth gear is simply obtained by locking the laygear to the pinion shaft. That is the clever bit.

OK, enough of this waffle; why **does** it unwind? The 2/3 hub is moved by a selector fork that operates on a collar screwed on to the end of the hub. This collar should be peened so that it cannot unscrew, but often isn't. When you drive forward, the collar tends to screw on, when reversing, the converse is true. However, as the selector fork is a clearance fit on the collar, this is not normally a problem. There are two factors that, combined, will unscrew the collar.

Firstly, the pair of pinions at the back of the box that transmit the drive from the mainshaft to the pinion shaft have helical teeth, so both shafts tend to move slightly endwise under high torque, and in opposite directions when reversing or on the overrun. This can be exacerbated by any end-float in the bearings, and can be more than the clearance between the collar and fork, which tends to be taken up when on the overrun in reverse.

As the hub, and therefore, collar, are free to move axially, this would be OK, if it were not for the fact that under high torque, the hub cannot slide easily.

So, we have this scenario:
Billy Brainless-Boyracer reverses at 30mph, the mainshaft slides forward. There is still a bit of fork-collar clearance at the front. He then takes his foot off without depressing the clutch. The mainshaft is shoved back by the heavy overrun, the collar rubs on the fork, and unscrews slightly – this makes it rub more. If he is lucky, it doesn't unscrew enough to cause a problem, and the next time he does a jack-rabbit start at the lights, it screws back on.
He may not be so lucky, and it unscrews so far that, as the fork cannot move, the hub slides forward until it starts to engage third gear, eventually stalling the engine. At this point, selecting neutral may get him out of reverse, leaving third permanently engaged, or, if he is even luckier, third may not be completely engaged and he can select first and pull away. If the collar is partially unscrewed, though, and the car is driveable, the splines on the rear of the hub that serve to lock the first/reverse pinion may rub against the latter, making a horrible noise and becoming damaged so that reverse cannot be engaged.
If the collar has unscrewed totally, the hub will move so far forward that the three protrusions on the third gear male cone come out of the splines on the input shaft.

OK, so now we know why it happens. So how do we prevent it happening, and, if you are unfortunately already in an unwound situation, how do you fix it?
Right – the first bit. If your gearbox has not unwound yet, drive your car up to about 20mph in first gear, then take your foot off, dipping the clutch as late as possible. This will ensure that the recalcitrant collar is screwed on tight.
Remove the heater hoses, disconnect the battery, and on a Dyane, remove the spare wheel support bar. Take the R-clip out of the gear link, and save the washers, noting their positions. Take out all the bolts holding the gearbox top on, carefully swinging brake pipe brackets vertically out of the way, so as not to bend the pipes too much. Note their positions. On a 2CV, the job will be easier if you take either front wing off.
As you remove the last bolts, the cover will start to lift at the front. In the centre of the front edge, a spring will start to become visible. For safety, tie some string round it to prevent it dropping into the gearbox when the cover is removed, or to retrieve it if it does.
Lift off the cover and put on one side. Retrieve spring.

In the hole where the spring was, there is a steel ball. If you move the second/third selector rapidly (don't worry – another few paragraphs and you will know what this is!) the ball will be flirted out, and obey the marmalade toast rule – result – ball in bottom of gearbox.
So, with one of those magnetic pickup tools, or a dob of grease, fish the ball out of the hole.
Now it is time to take stock of what we can see. There are three long shafts running the length of the gearbox, and these have bronze thingies attached to them. These are selector shafts and forks. The centre one is for second and third (told you!).
If you look at the latter fork, at the rear end, you will see that it wraps round a steel collar – the villain of the piece.
If you rotate the collar you will see that the hub it screws on to has about eighteen grooves on the threaded portion, and that the flange on the collar may have been peened into some of these grooves.
If the box has unwound, you will need to screw the collar back on. If it was a bad case of unwinding, the hub may have moved so far forward that the protrusions on the male cone have become disengaged from the splines on the second gear pinion, in which case you need to try to rotate the cone with something like a scriber – it is the thing inside the end of the hub. There are three positions where it can engage and the hub can be slid rearwards. Easier to do than describe.
When you have screwed the collar on, get a very small chisel or centre punch, and peen the collar into all of the grooves on the hub. It does not require heavy blows, which may bend the mainshaft.
OK – job done. Ideal opportunity to change gearbox oil as well. Before you replace the lid, put a tiewrap round the 'beret' to stop the oily mess all over the lid. If the box has done lots of miles, the following is worth doing to give a smoother gearchange:
Drill out rivet that retains 'hairpin' spring in cover, remove spring and gear lever. Wash everything off, and examine inside edges of spring for roughness. Remove this with a fine oilstone. Cover lever ball in copper or nickel grease and reassemble, using M7 nut and bolt in place of rivet. Bolt on inside, nut outside. Cut bolt off nearly flush with nut and peen over. Clean mating faces of cover and box.
Put a wodge of grease down the hole in the front edge where the ball goes, and shove said ball in, followed by its mate, spring. Fit cover very carefully, using Hylomar or similar jointing in moderation. Ensure gear lever is vertical and engages selectors correctly.
Tighten two opposite bolts, but not completely, and test that all gears can be engaged.
Finish reassembly in Haynes tradition (reverse order of dismantling)
Now you can reverse at 30mph, and take your foot off, with impunity. Keep doing this, and your gearbox will have a first/reverse whine like Billy B-R's Saxo/Nova/Fiasco, and the magnet on your drain plug will acquire a comfort blanket of case-hardened steel whiskers like Epping Forest.
Possible problems:
It is possible that if the car has managed to be driven in a partially unwound state in third gear, the splines on the sliding reverse pinion have been rubbing against those on the hub, next to the collar, and have either burred the splines over, in which case reverse cannot be engaged, or just chewed them up, so either reverse jumps out, or there is no drive at all in reverse. The cure for this requires the box to be dismantled, so exceeds the scope of this article.